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NUCLEAR SCIENCE ABSTRACTS

CHEMISTRY

Analytical Chemistry

Chemical and Spectral Procedures

Refer also to abstracts 36300, 36336, 36344, 36345, 36374, 36378, and 36924.

36141 (ARH–1609) ATOMIC ABSORPTION AND FLAME EMISSION SPECTROSCOPY ANALYSES OF BASALT CORE SAMPLES FROM A DEEP WELL. Kupfer, M. F. (Atlantic Richfield Hanford Co., Richland, Wash). Mar 1970. 17p. Dep. CFSTI.

Atomic absorption was found to be a fast and accurate method for determining the major metal oxides and several trace elements in basaltic rock flows. Rock samples were fused with lithium metaborate, then dissolved with dilute hydrochloric acid. Trace elements as well as the major constituents were easily analyzed from the fusion solution. Experimentation also showed that a treatment of this solution with ion exchange followed by a dithizone-ethyl propionate extraction enabled a 15-fold improvement in the detection limits of Pb, Co, Cu, and Ni. Water samples were successfully analyzed by atomic absorption and flame emission for 19 elements. Determinations were made directly or from dilutions of the samples. Several trace elements of very low concentrations were chelated with ammonium pyrollidine dithiocarbamate and extracted into methyl isobutyl ketone. This extraction effectively improved detection limits of the elements up to 30-fold. (auth)

36142 (ARH–1615) ADIABATIC VACUUM DISTILLATION TO FRACTIONATE PARAFFIN HYDROCARBON MIXTURES (C_8–C_{14}). Mulligan, Dawn L.; Stubblefield, C. T. (Atlantic Richfield Hanford Co., Richland, Wash.). Sep 1969. 19p. Dep. CFSTI.

A pure, straight-chain paraffin hydrocarbon mixture (C_8–C_{14}) is the diluent for tributyl phosphate extractant used in reprocessing spent uranium fuel elements. Precise adiabatic vacuum distillation, following a density fractionation, provided more sensitive qualitative analysis of industrial paraffin mixtures. Trace contaminants were concentrated to enhance further identification. Conclusions were supported by gas-liquid chromatography and ultraviolet spectrophotometry. (auth)

36143 (CEA-N–1241, pp 3-83) CHEMICAL ANALYSES. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). (In French).

Developments made in chemical and electrochemical analysis are reported. They include the coulometric determination of water in sodium peroxide and the EDTA titration of neodymium. Techniques for isotope analysis by mass spectrometry were improved by using a digital analyzer and a method for the determination of neodymium in U–Pu irradiated fuels is given. Methods for the analysis of Pu are described. Influence of Co on the oxido-reduction and the titration of Pu was studied, and chronoamperometry applied to the determination of chlorides in Pu solutions. An α, β, γ installation for the analysis of radioactive materials was constructed and its design is outlined. Developments and improvements made in the spectrometric methods by optical emission, atomic absorption, and x-ray fluorescence are reported. The techniques developed and their efficiency in the determination of Ti, Ge, V, and Tc in U and the determination of U in Zr are described. The use of fluoride and chloride carriers in the analysis of Sicral type alloys is discussed. In the analytical program for the control of nuclear materials and fuels, methods were adapted or developed for the determination of impurities in uranium and uranium fluorides and for the control of Pu and U cycles. The activities of the Cadarache analytical laboratory are presented. (France)

36144 (FOA–4-4422-24) DETERMINATION OF GALLIUM IN GALLIUM–PLUTONIUM ALLOYS. I. DETERMINATIONS WITHIN THE CONCENTRATION RANGE 1 TO 10 PERCENT OF GALLIUM BY EDTA-TITRATION. Andersson, L.-H.; Gelin, B. (Forsvarets Forskningsanstalt, Stockholm (Sweden)). Apr 1970. 12p. (In Swedish). Dep. CFSTI (U. S. Sales Only).

The sample was dissolved in 5 moles HCl. Ascorbic acid was used as reducing agent. Gallium as an anion complex; $GaCl_4^-$, was fixed on an anion exchanger, Dowex 1. Gallium was eluted with 0.5 moles HCl. The titration was done with EDTA at a pH of 3.0 to 3.5 with the indicator copper-PAN at a temperature of 75 to 100°C. The standard deviation for a single determination was 0.007 mg Ga in the concentration range 0.5 to 15% Ga in Pu for a sample size of 100 mg. (Sweden)

36145 (LA–4439) DETERMINATION OF OXYGEN IN REFRACTORY OXIDES: GAS CHROMATOGRAPHIC METHOD. Vance, D. E.; Smith, M. E.; Waterbury, G. R. (Los Alamos Scientific Lab., N. Mex.). Apr 1970. Contract W-7405-eng-36. 7p. Dep. CFSTI.

The oxygen content of refractory oxides is obtained by measuring with a gas chromatograph the carbon monoxide and carbon dioxide formed when the oxide is reacted with carbon at 2000°C in a stream of helium. To ensure complete reaction, 1 g of the oxide and 0.2 g of graphite are ground together, pelletized, and heated in a carbon crucible. The carbon monoxide and carbon dioxide evolved are adsorbed on a silica gel trap immersed in liquid nitrogen. These gases are desorbed by heating; flushed, along with a measured volume of neon to serve as an internal standard, into a 2-liter reservoir by a stream of helium; and mechanically mixed. A measured volume of the mixed gases is injected into the gas chromatograph by means of a sampling valve, and the quantities of carbon monoxide and carbon dioxide are obtained by electronic integration of the areas under the resultant chromatographic peaks. From these values, the quantity of oxygen in the refractory oxide is calculated. The relative standard deviations for a single determination are 0.6 and 0.8% in determining oxygen in uranium oxide and (uranium, plutonium) dioxide, respectively. (auth)

36146 (LUNP–7006) X-RAY ANALYSIS: ELEMENTAL TRACE ANALYSIS AT THE 10^{-12} g LEVEL. Johansson, Thomas B.; Akselsson, Roland; Johansson, Sven A. E. (Lund Inst. of Tech. (Sweden). Dept. of Nuclear Physics). Apr 1970. 13p. Dep. CFSTI (U. S. Sales Only).

X-ray analysis, using protons in the MeV region as excitation source and a high resolution Si(Li)-detector to detect the characteristic x-rays, was capable of detecting many elements at the 10^{-12} g level simultaneously in a short run. To minimize the background contribution from bremsstrahlung, thin carbon foils were used as backings. (auth) (Sweden)

36147 (RT/CHI–(69)26) THORIUM: DIRECT POTENTIOMETRIC DETERMINATION IN ORGANIC SAMPLES. PART I. Altamura, V.; Pompei, V.; Siciliano, F. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 10 Nov 1969. 27p. (In Italian). Dep. CFSTI (U. S. Sales Only).

The method described allows the direct potentiometric deter-

mination of thorium in 30% TBP–kerosene organic mixture. The potential break, taken for the end point, is recorded by means of a potentiograph. The method is simple and suitable for routine application, because of its rapid execution, the possibility of remotizing the necessary equipment, and the extent of the error, which can be confined within 3%. (auth)

36148 (RT/CHI–(70)4) THORIUM: DIRECT POTENTIOMETRIC DETERMINATION IN ORGANIC SAMPLES. PART II. STATISTICAL EVALUATION OF RESULTS OBTAINED. Altamura, V.; Pompei, V.; Siciliano, F. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 19 Jan 1970. 19p. (In Italian). Dep. CFSTI (U. S. Sales Only).

With the help of linear relation statistics and regression analysis, the linearity of the new method, which is also free from procedural errors proportional to the concentration of the component to be determined in the experimental concentration range, was verified. For the same range the optimum concentration was established for future samplings. For these samples the variation coefficient would be about 1%. (auth)

36149 UTILIZATION OF HALOGENATED CARRIERS FOR URANIUM SPECTROGRAPHIC ANALYSIS. Neuilly, M. (CEN, Grenoble, France); Ranquet, P.; Baudin, G.; Pichat, R.; Heres, A.; Simenauer, A. Method. Phys. Anal.; 6: 68-77(Mar 1970). (In French).

From 15th International Spectroscopy Colloquium, Madrid, Spain.

Tests carried out in different laboratories of the CEA on spectrographic analysis of uranium with halide carriers are reviewed. Thermodynamic considerations influence the choice of a carrier. The chief advantages of this method compared with the original Scribner's one are: possible determination of refractory oxide elements; less importance given to the granulometry of the matrix U_3O_8; elimination of the possibility of error in the high grade determinations. (France)

36150 URANIUM CONTENT OF SOME DENTAL PORCELAINS AND BETA-ACTIVITY. Nally, J. N.; Meyer, J. M.; Niederer, J. (Univ., Geneva). Helv. Odont. Acta; 13: No. 1, 32-5(1969).

X-ray fluorescence analysis of fused dental porcelain was obtained by using Mo radiation and LiF as the analyzing crystal. Up to 2% of U was detected in the porcelain. The β-activity of the samples was determined with a Geiger–Mueller halogen counter. The maximum absorbed equivalent dose per 1 g of porcelain was 3.81 Rem per yr. (Anal. Abstr.)

36151 SPECTROPHOTOMETRIC STUDY AND ANALYTICAL APPLICATION OF RARE EARTH TIRON COMPLEXES. I. DETERMINATION OF NEODYMIUM, HOLMIUM, AND ERBIUM. Taketatsu, Tomitsugu; Toriumi, Nobuyo (Kyushu Univ., Fukuoka). Talanta; 17: 465-73(Jun 1970).

The absorption spectra of neodymium, holmium, and erbium Tiron complexes in aqueous solution have been measured from 340 to 650 nm. The absorbance at the wavelength of maximum absorption band of an aqueous medium containing neodymium (pH 4.5), neodymium (pH 12.0), holmium (pH 5.0), and erbium (pH 5.0) Tiron complexes was about 4 (at 578 nm), 9 (at 571 nm), 9 (at 450 nm) and 5 (at 376 nm) times greater, respectively, than for the same quantities of the corresponding chlorides. The spectrophotometric determination of these elements has been investigated. Combining ratios of Tiron to rare earth have been found to be 3 : 2 and 2 : 1. (auth) (UK)

36152 SOME OBSERVATIONS ON THE CHOICE OF A SOLVENT IN THE SPECTROPHOTOMETRIC DETERMINATION OF MOLYBDENUM BY TOLUENE-3,4-DITHIOL. Ssekaalo, H. (Animal Health Research Centre, Entebbe, Uganda). Lab. Pract.; 19: 603-4(Jun 1970).

Amyl acetate, benzene, carbon tetrachloride and chloroform were examined as solvents for the complex in the spectrophotometric determination of molybdenum by toluene-3, 4-dithiol in order to determine the most suitable one. Some spectral characteristics of the complex in each of the solvents were determined. Carbon tetrachloride was found to be the most suitable solvent. (auth) (UK)

36153 REMOTE ANALYSES BY ATOMIC ABSORPTION SPECTROPHOTOMETRY. Sovereign, William R.; Ebersole, Earl R.; Villarreal, Robert; Hareland, Willard A. (Argonne National Lab., Idaho Falls, Idaho). Nucl. Appl. Technol.; 9: 416-21(Sep 1970).

A remotely operated atomic absorption system was developed for the routine determination of metallic constituents at macro and trace levels in highly irradiated nuclear fuel. A special optical system in the hot cell directs a light signal to a monochromator and associated readout equipment located outside the cell. The same monochromator and readout equipment serves an atomic absorption instrument located outside the cell for analysis of nonirradiated material. The sensitivity and precision of the two systems is essentially the same. The time required for wet chemical analyses of irradiated fuel was reduced by a factor of 8 to 10 with the remote atomic absorption system. (auth)

36154 SIMULTANEOUS SPECTROPHOTOMETRIC DETERMINATION OF ZIRCONIUM AND HAFNIUM. Dragulescu, C.; Policec, S.; Simonescu, T. Talanta; 17: 567-75(Jul 1970). (In German).

Zirconium may be determined in the presence of hafnium by ultraviolet spectrophotometry at the isosbestic wavelengths of 218.2, 243.3 or 298.8 nm, with anthranil-N,N,-diacetic acid [indexed as N,N-bis-(carboxymethyl)anthranilic acid] in dilute acid solution. Hafnium may be determined in the presence of zirconium from measurements at 216.5, 242.5 or 297 nm. Concentrations in the range 2 to 36 μg/ml (Zr) and 3 to 70 μg/ml (Hf) may be determined, and in admixture, from 2.5 to 80% of Zr in Hf, and vice versa, with an error of 3 to 4%. (auth) (UK)

36155 WATER–CO_2 EXCHANGE SET-UP FOR THE ROUTINE ^{18}O ASSAY OF NATURAL WATERS. Roether, Wolfgang (National Physical Research Lab., Pretoria). Int. J. Appl. Radiat. Isotop.; 21: 379-87(Jul 1970).

A new procedure of sample preparation for the ^{18}O assay of water is described. It is based on the common principle of equilibrating the water samples with CO_2 gas, the isotopic composition of which is then analysed in the mass spectrometer. However, handling time is reduced to about 10 min per sample by operating several samples in parallel, and by pumping the air from the equilibration vessels through capillary tubes without freezing down the water samples. The capillaries control the loss of water vapor and prevent mixing between the samples. The vessels are shaken during pumping and during the equilibration. The isotopic enrichment caused by the vapor loss was found to be about 0.1 per mil for 1 ml samples and it is proportionally smaller for larger samples. For 10 ml water samples at 18°C, the characteristic time of equilibration drops by an order of magnitude between 2 and 3.5 c/s shaking frequency after which it levels off to 18 min; the slow step is then the hydration reaction of the dissolved CO_2. The standard reproducibility of sample preparation is better than ±0.03 per mil and no difference in isotopic composition to that of samples prepared in the classical manner has been detected. (auth) (UK)

36156 FEW REMARKS ON THE IDENTIFICATION OF INORGANIC COMPOUNDS. Lederer, M. (CNR, Rome). J. Chromatogr.; 48: 387-9(22 Apr 1970).

From 4th International Symposium on Identification of Substances by Paper and Thin-Layer Chromatography, Rome, Italy. See CONF-690956.

Three examples of identification of inorganic compounds, including thorium compounds, by chromatography are discussed. Various references are cited. (B.L.M.)

36157 RELATIVE SENSITIVITY OF RARE EARTH ELEMENTS IN SPARK-SOURCE MASS SPECTROMETRY. Roaldset, Elen (Univ. of Oslo). Talanta; 17: 593-8(Jul 1970).

A method for calculating the relative sensitivity factors for the rare earth elements in geological material is outlined. A close correlation is found between the relative sensitivity factors calculated and isotopic mass and the first ionization potential for the elements. The points are grouped in the vicinity of a regression line, which may be used to determine the relative sensitivity factors for all the rare earth elements. (auth) (UK)

36158 ISOTOPIC ANALYSIS OF KRYPTON WITH A LOW BACKGROUND MASS SPECTROMETER. Miyake, Hiroshi (Kobe Univ., Japan). Kobe Shosen Daigaku Kiyo, Dai-2-Rui, Kokai, Kikan Rigaku-hen; No. 17, 133-8(Mar 1970). (In Japanese).

High-sensitivity mass spectrometry of Kr was carried out with a very-low-background mass spectrometer. The backgrounds at mass regions above 50 were not observed except the cracking pattern of benzene as high as 1×10^{-12} torr. The memory of Kr decreased with pumping time proportional to $t^{-\frac{1}{2}}$. Main sources of systematic errors are discussed. (auth) (NSA of Japan)

36159 DIRECT SPECTROPHOTOMETRIC DETERMINATION OF URANIUM IN ORGANIC SOLUTIONS OF TRI-n-BUTYL PHOSPHATE WITH ARSENAZO III. Emura, Satoru (Japan Atomic Energy Research Inst., Tokai). Jap. Anal.; 19: 637-42(May 1970). (In Japanese).

For direct spectrophotometric determination of U in organic solutions of tributyl phosphate (TBP) with Arsenazo III, an attempt was made to retain uranyl-Arsenazo III complex in a homogeneous

mixture of 30% TBP/diluent–butyl cellosolve–water. The uranyl-Arsenazo III complex in this medium had an absorption maximum at 653 nm and the absorbance showed a constant value at ~0.16M HNO_3. Beer's law was obeyed up to 5.6ppM of U (VI) and the apparent molar absorptivity at 653nm was 3.58×10^4. The uranyl ion formed with Arsenazo III only a 1:1 chelate in 30% TBP/isododecane–butyl cellosolve–water medium. The mutual solubility between the organic solution and the aqueous solution of the reagent, the determinable region of U (VI) and the effects of diluents of TBP and diverse ions are also discussed. (auth) (NSA of Japan)

36160 IMPROVEMENTS IN OR RELATING TO THE ANALYSIS OF MATERIALS. Dziunikowski, Bohdan Wladyslaw (to United Kingdom Atomic Energy Authority). British Patent 1,191,936. 13 May 1970. Filed 27 Sep 1967.

A technique of x-ray fluorescence analysis employing artificial or natural radioisotope radiation sources for stimulating fluorescence is described. The method overcomes the difficulty of the interelement effect, which is not always met entirely satisfactorily by the use of balanced filters. Fluorescent rays are stimulated from the sample using backscatter geometry, and balanced absorption edge filter pairs are employed. As an example the determination of Cu in the presence of Fe is described. If the wanted element and the major interfering element are very close as regards their characteristic energies one filter from each of the two balanced filter pairs may be common, so that in practice only three actual filters are required. (U.K.)

36161 THE SOLVENT EXTRACTION OF ANIONS WITH METAL CHELATE CATIONS. XLIII. SPECTROPHOTOMETRIC DETERMINATION OF MOLYBDENUM BY SOLVENT EXTRACTION WITH TRIS(1,10-PHENANTHROLINE)IRON(II) CHELATE CATION. Tanaka, Takashi; Hiro, Kazuo; Yamamoto, Yuroku (Government Industrial Research Inst., Osaka). Nippon Kagaku Zasshi; 91: 354-8(Apr 1970). (In Japanese).

A spectrophotometric method for the determination of molybdenum was developed by means of solvent extraction. Even a small amount of molybdenum was preferentially extracted into nitrobenzene when a large excess of oxalic acid and a considerable amount of tris(1, 10-phenanthroline)iron(II) chelate cations were present in an aqueous phase. Constant extractability was observed over the pH range of 1.6 to 2.5, provided oxalic acid and the metal chelate concentrations were 800-fold and 15-fold excess, respectively, over molybdenum on the molar basis. The absorbance at λ_{max}(516 mμ) of the extract was found to be proportional to the initial molybdenum concentration in the aqueous phase in the range from 8×10^{-6} to 4×10^{-5} moles/l. The color intensity of the extract was almost unchanged even by 24 hr standing after the extraction. The standard deviation was calculated to be 0.0059 absorbance unit from a mean value of $0.447(2 \times 10^{-6}$ moles/l in molybdenum concentration, 10 samples). Diverse ions except Sn (IV), W(VI) and Ti(IV) did not interfere with the determination. A large amount of iron caused a small negative error, and another calibration curve with good linearity was obtained in pure iron matrix, and the proposed method was applied to analysis of molybdenum in steel with satisfactory results. (auth)

36162 SPECTROPHOTOMETRIC DETERMINATION OF YTTRIUM IN CHROMIUM AND CHROMIUM-BASE ALLOYS WITH ARSENAZO III. Wood, D. F.; Adams, M. R. (Imperial Metal Industries Ltd., Birmingham, Eng.). Analyst; 95: 556-61(Jun 1970).

A method was developed for determining yttrium in the range 50 ppM to about 4% in chromium and chromium-base alloys. The procedure involves the separation of yttrium from chromium(VI) by precipitation of yttrium hydroxide from an ammoniacal chloride solution; aluminum hydroxide is used as a "collector." The mixed hydroxides are dissolved in dilute nitric acid, and yttrium is subsequently determined spectrophotometrically by a procedure based on the formation of a blue-colored complex with Arsenazo III. Absorbance of the complex is measured at a wavelength of 660 nm. The effects of common alloying constituents and likely impurities were investigated, and modifications to the method were introduced to overcome interference by aluminum, iron, titanium, zirconium, hafnium, niobium, and tantalum. (auth) (UK)

Isotopic Procedures

36163 (BAW-3809-7) POSTIRRADIATION EXAMINATION OF THORIA–URANIA FUEL RODS. ISOTOPIC ANALYSIS OF THE FUEL. Final Report, Volume 2 of 3 Volumes. Bishop, W. N.; Marsh, S. F.; Williams, R. L.; Wolfe, G. E. (Babcock and Wilcox Co., Lynchburg, Va. Research and Development Div.). Oct 1969. Contract AT(30-1)-3809. 106p. Dep. CFSTI.

Thirteen fuel rods from Core A of the Indian Point Reactor were analyzed for the isotopic content of selected actinide and fission product elements. Samples of the thoria–urania fuel were dissolved in 13 M nitric–0.05 M hydrofluoric acid, chemically separated and analyzed for the isotopic composition of thorium, uranium, neptunium, plutonium, americium–curium, neodymium, promethium, samarium, and cesium. Neptunium was separated by a solvent extraction procedure in which Np(VI) was extracted into methyl isobutyl ketone–tetraheptylammonium chloride from a hydrochloric acid solution. A sequential separation procedure was developed for the separation of uranium, plutonium, neodymium, promethium, samarium, and americium–curium. This procedure utilizes two extraction chromatography columns and two inorganic ion exchange columns. The separated samples were analyzed by mass, alpha and gamma spectrometry. The rods showed a wide range of burnup and thus the isotopic compositions of the samples were varied. In one sample the ^{235}U was depleted to less than one-fourth of the initial amount, and in another sample the ^{235}U depletion was only about 15%. The samples that had experienced high burnups showed large amounts of ^{233}U produced from thorium. Plutonium-238 composed a major fraction of the plutonium in several fractions. This is attributed to the high ^{235}U enrichment. The isotopic concentrations were calculated from reactor design and operating parameters. The results showed fair agreement with the experimental values but consistently predict lower burnup than was obtained experimentally. (auth)

36164 (EURFNR-730) ANALYSIS OF NEPTUNIUM IN NUCLEAR FUELS. Braun, H.; Brandalise, B.; Koch, L. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Radiochemie). Translation of report KFK-1115. 18p. Dep. CFSTI.

Work Performed under United States–Euratom Fast Reactor Exchange Program.

An abstract of this paper, prepared from the original language, appeared as NSA 24: 18900.

36165 KINETICS OF REDUCTION OF β-UO_3 BY METHANE. Semavin, Yu. N.; Vlasov, V. G. (Ural Polytechnic Inst., Sverdlovsk, USSR). Izv. Vyssh. Ucheb. Zaved., Tsvet. Met.; No. 6, 73-7(1969). (In Russian).

Studies were made on the kinetics of reduction of β-UO_3 by methane in the temperature range 600 to 800°C and pressures of 50 to 550 mm Hg. The value for the activation energy for the process was constant and equal to 31.8 ± 1.0 kcal/mole. It was established the reduction process is developed autocatalytically. An equation is given for the relation of the rate of reduction to the pressure of methane. A correlation between the kinetic characteristics of reduction of β-UO_3 by methane and data on x-ray-phase analysis of the intermediate products of reduction is given. (tr-auth)

Radiometric Procedures

Refer also to abstracts 36425, 36559, 36585, and 37184.

36166 (DP-Report-89) EXPERIMENTS ON SEPARATION PROCEDURE FOR KRYPTON AND XENON IN CONNECTION WITH PLUTO LOOP RADIOCHEMICAL SAMPLING. Project DRAGON. Lengweiler, H. (Atomic Energy Establishment, Winfrith (England)). Apr 1962. 21p. Dep. CFSTI.

In order to simplify the radiochemical analysis of the fission products to be sampled from Pluto Loop, experiments on a separation procedure for krypton and xenon were carried out. It is shown that gas chromatography at low temperature, using Molecular Sieve 5 A as absorbent, makes it possible first to separate quantitatively Kr and Xe in a quick and simple way and secondly to detect easily the shorter-lived rare gases such as ^{88}Kr and ^{138}Xe by means of their daughter products. (auth)

36167 (JINR-D6-4649) SEARCH FOR VERY FAR TRANSURANIUM ELEMENTS IN IRON-MANGANESE NODULES. Otgonsuren, O.; Perelygin, V. P.; Flerov, G. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1970. 12p. Dep. CFSTI (U. S. Sales Only).

A search for the effect due to the fission of very far transuranium elements in manganese nodules got in the south region of the Pacific Ocean was made. A great number of the fission fragment tracks (from 7 to 120 track/mm^2) was observed on the minerals (from the feldspar group) contained in some of the nodules. The analysis shows that not more than 10 to 20% of the effect observed are due to the spontaneous fission of uranium. One of the possible explanations of the observed excess of tracks is the assumption on the spontaneous fission of very far transuranium elements of the earth or cosmic nature contained in the manganese nodules. (auth)

36168 (JUL-603-ST, pp 203) ACTIVITY AND SHIELDING: RADIOCHEMICAL SEPARATION. Jacobs, H.; Schoch, R.;

Kokemueller, H. J. (Kernforschungsanlage, Juelich (West Germany). Zentralabteilung Strahlenschutz). (In German).

Quantitative assessment of thorium down to the microgram range is possible with spectrometric methods. To determine smaller amounts, ^{234}Th was used as a tracer. Its short-lived daughter, ^{234}Pr, emits high-energy beta particles that can easily be measured. ^{234}Th is separated from natural uranium through an ion exchange column. An ion exchange process is discussed that allows the separation of calcium, barium, and strontium in one workstep and, if the three elements are radioactive, their radiochemical identification and quantitation. In the range between 10^{-12} and 10^{-9} Ci, recovery is approximately 90%. (H.B.G.)

36169 (JUL-650-CA) DETERMINATION OF ^{232}U AND ITS DAUGHTERS IN IRRADIATED URANIUM-THORIUM NUCLEAR FUELS. Stoeppler, Markus; Petri, Hermann (Kernforschungsanlage, Juelich (West Germany). Zentrallabor fuer Chemische Analyse). Mar 1970. 25p. (In German). Dep. CFSTI (U. S.

Aliquots from radiochemically separated and purified U fractions of solutions from irradiated nuclear fuels containing U and Th were measured with the aid of γ spectrometry and α spectrometry. Values obtained for the atomic ratios of ^{232}U to ^{233}U and of ^{232}U to the total amounts of U are given. (auth)

36170 (NP-18291) BURN-UP STUDIES WITH A FOUR METER BENT CRYSTAL SPECTROMETER. Boreving, S.; Falkstroem-Lund, E.; Rohlin, J.; Ryde, N. (Forskningradens Laboratorium, Studsvik (Sweden)). 1969. 30p. (LF-25). Dep. CFSTI (U. S. Sales Only).

The main advantage of the crystal diffraction method for burn-up studies is that it gives a sufficiently large energy resolution and that it presents a possibility to use the scintillation detector outside the intense and complex direct gamma beam from the irradiated fuel element. A four-meter bent crystal diffraction spectrometer was used to determine the Cs-content in fuel elements by measuring the intensity of the 0.662 MeV gamma line from the decay of ^{137}Cs. From reactor operational conditions the Cs-migration was estimated to be negligible in the samples used in this case. The migration was furthermore experimentally checked to a certain extent by comparative measurements on migration-stable nuclides. From the results given it is seen that within certain limits of the irradiation, as a moderate neutron flux and irradiation time, the method is able to give the fuel burn-up with an error of less than 8%. (Sweden)

36171 (NP-18293) SOME STUDIES ON THE BURN-UP OF NUCLEAR FUEL. Forsyth, Ronald Stewart (Aktiebolaget Atomenergi, Studsvik (Sweden). Stockholm Univ. (Sweden). Inst. of Inorganic and Physical Chemistry). 1970. 32p. Dep. CFSTI (U. S. Sales Only).

Thesis.

A short review of the problems involved, and the techniques used, in determining the burnup of nuclear fuel is given. Contributions on destructive and nondestructive analysis are described. The principles of the use of stable fission product nuclides are presented, and illustrated by the use of the stable fission product molybdenum isotopes. The applications of both NaI detectors and Ge(Li) detectors for the gamma spectrometric examination of irradiated fuel are described. (auth)

36172 (RT/PROT-(69)44) NEW RADIOTOXICOLOGICAL METHODS USED AT THE ITALIAN NUCLEAR CENTER OF CASACCIA. Testa, C. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 12 Nov 1969. 25p. (In Italian). (CONF-690638-1). Dep. CFSTI (U. S. Sales Only).

From 11th Conference of Industrial Medicine, Usti nad Labem, Czechoslovakia.

Nuclear workers are often exposed to a risk of internal contamination from radionuclides; in the case of alpha- and beta-emitting radioisotopes the only means to detect and determine internal contaminations are radiotoxicological excreta analyses, particularly of the urine. Sensitive and rapid methods are described for the determination of enriched uranium, natural thorium, plutonium-239, and strontium-90 in the urine by applying reversed-phase partition chromatography techniques. Natural thorium and enriched uranium can be separated from the urine on a column of Microthene impregnated with trioctylphosphine oxide (TOPO); for separation of plutonium-239 a Kel-F-trioctylamine (TNOA) column is used, finally strontium-90 is separated by isolating yttrium-90 on columns of Microthene supporting di-2-ethylhexyl phosphoric acid. Good results were also obtained by means of batch extraction. (auth)

36173 (SWRHL-11) SOUTHWESTERN RADIOLOGICAL HEALTH LABORATORY HANDBOOK OF RADIOCHEMICAL ANALYTICAL METHODS. Johns, Frederick B. (Public Health Service, Las Vegas, Nev. Southwestern Radiological Health Lab.). Mar 1970. 122p.

36174 DETERMINATION OF AGE BY LIQUID SCINTILLATION SPECTROMETRY: SIMPLIFIED BENZENE SYNTHESIS, ALSO FROM SMALL CO_2 QUANTITIES. Scharpenseel, H. W.; Pietig, F. (Univ., Bonn). Atompraxis; 16: 185-6(May-Jul 1970). (In German).

A benzene production line for radiocarbon dating is shown. By comparison with existing commercial benzene synthesizers, its production costs are low; furthermore, small samples can be measured. The available sample CO_2 is attenuated up to normal volume with guaranteed dead CO_2 gas from a pressure tank. The content of sample carbon in the benzene sample equals the pressure ratio of sample over total CO_2. (auth)

36175 METHOD FOR RECORDING $\beta-\beta$ REFLECTION. Boyarshinov, L. M. (Moscow Inst. for Fine Chemical Tech.). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 6, 111-5(1969). (In Russian).

In earlier studies it was reported that the sensitivity and the resolution of the analytical method based on the reflection of β radiation emitted by radioactive ores may be improved by means of $\beta-\beta$ reflection, involving multiple reflections from the other surface of the specimen; however, this requires that the other surface be available for handling during the analysis. This requirement made it impossible to use the method in field analyses of rocks or for moving specimens. An improved version of the multiple reflection method was developed requiring only one surface of the specimen. The reflection is carried out by means of a suitably placed lead or bismuth sheet. The energy and the intensity of the reflected radiation were found to be sufficiently high to be recorded. The dependence of the intensity on the atomic number is close to a Z^2 relation. The method presents the advantages of both single and multiple reflection techniques without their shortcomings. (TTT)

36176 RADIOMETRIC PROBLEMS RELATED TO STUDIES OF TRITIUM AND ^{14}C IN HEALTH PHYSICS PRACTICE. Kollar, Josef; Chorvat, Dushan; Tatara, Milar (Vyzkumny Ustav Psychiatricky, Prague). Prac. Lek.; 22: 18-24(Jan 1970). (In Slovak).

The literature (88 references, mostly in English) on the problems of measuring traces of T and ^{14}C in the environment is reviewed. Sources of these radionuclides are mentioned, e.g., cosmic ray irradiation of Earth targets and production in nuclear explosions. Scintillation counters and the ancillary electronics are discussed, together with problems of dosimetry of beta particles, interfering radionuclides, and the use of scintillators. (TTT)

36177 DIRECT PLATING OF RADIOCARBON AS CALCIUM CARBONATE. Benech, C.; Levitas, A.; Franchi, C. M. (Instituto de Investigacion de Ciencias Biologicas, Montevideo). Arch. Soc. Biol. Montevideo; 27: Special No., 30-5(1969).

Biological material is wet ashed and the carbon dioxide absorbed in 0.25 N sodium hydroxide solution. The sodium carbonate is then added to a boiling solution of 1 M calcium chloride. After cooling to room temperature, the calcium carbonate settles to the bottom within one minute. After several washings in distilled water and ethanol, the sediment is plated directly onto aluminum cupped planchets for counting in a Geiger Mueller tube. The advantages of the method for ^{14}C counting, the back scattering, and the self absorption are discussed and presented in two diagrams. (H.B.G.)

36178 URANIUM DETERMINATIONS IN DEEP-SEA SEDIMENTS AND NATURAL WATERS USING FISSION TRACKS. Bertine, K. K.; Chan, L. H.; Turekian, K. K. (Yale Univ., New Haven). Geochim. Cosmochim. Acta; 34: 641-8(Jun 1970).

Uranium determinations by induced fission track analysis were done rapidly utilizing a discharge counter instead of visual counting. Sediments, rocks, freeze-dried river salts (with Na_2CO_3 carrier) and one freeze-dried sea salt were analyzed by this technique. Comparisons with samples whose uranium concentrations were determined independently indicate that the method is accurate. The uranium concentration in deep-sea sediments varies widely with oceanic depth and depth in the core ranging from 0.5 to 40 ppM U on a calcium carbonate-free basis. Seventeen river water samples range between <0.01 and 1.2 μg U/l with an average value of 0.27 μg U/l. (auth) (UK)

36179 INCREASED SENSITIVITY IN SPECTRAL RADIOMETRIC ANALYSIS OF ROCK SAMPLES. Yakubovich, A. L.; Zaitsev, E. I.; Anosov, V. V. This paper was summarized in At. Energ. (USSR); 27: 52(Jul 1969) as paper No. 319/4182. (In Russian).

Simultaneous γ radiation counts at energies of 93, 240, and 350 keV and 1.46 MeV are used for analysis of rocks. The method was evaluated for determination of U, Ra, Th, and K. (M.C.G.)

36180 NEW BORON ANALYSIS METHOD. Weitman, J.; Daverhoeg, N.; Farvolden, S. (Aktiebolaget Atomenergi, Studsvik, Sweden). Nucl. Appl. Technol.; 9: 408-15(Sep 1970).

In connection with fast neutron (n,α) cross section measurements a boron analysis method was developed. The boron concentration is inferred from the mass spectrometrically determined number of helium atoms produced in the thermal and epithermal ^{10}B (n,α) reaction. The relation between helium amount and boron concentration is given, including corrections for self shielding effects and background levels. Direct and diffusion losses of helium are calculated and losses due to gettering, adsorption and HF-ionization in the release stage are discussed. A series of boron determinations is described and the results are compared with those obtained by other methods, showing excellent agreement. The lower limit of boron concentration that can be measured varies with type of sample. In steel, for example, concentrations below 10^{-5}% boron in samples of 0.1 to 1 g may be determined. (auth)

36181 DETECTION LIMIT FOR GOLD BY RADIOISOTOPIC X-RAY ANALYSIS. Burkhalter, P. G.; Marr III, H. E. (Bureau of Mines, College Park, Md.). Int. J. Appl. Radiat. Isotop.; 21: 395-403(Jul 1970).

The use of a Ge(Li-drifted) semiconductor detector and gamma-ray excitation with radioisotopic sources provides an x-ray analytical method that is advantageous for the determination of high-Z elements in ores. The 122-keV gamma radiation of ^{57}Co was found to be an optimum energy for exciting gold K-radiation. The detection limit for gold was determined to be 30 to 40 ppM using both synthetic standards and analyzed gold ores. With a source strength of 60 mCi, a 21-ppM detection limit is obtainable in 3-min counting times. The sensitivity of the radioisotopic x-ray method for several other high-Z elements was also determined. Using ^{57}Co for excitation, the detection limits for tungsten, lead, and uranium were 25, 40 and 60 ppM, respectively. (auth) (UK)

36182 ^{210}Po and ^{210}Pb IN THE MARINE ENVIRONMENT. Shannon, L. V. (Div. of Sea Fisheries, Cape Town); Cherry, R. D.; Orren, M. J. Geochim. Cosmochim. Acta; 34: 701-11 (Jun 1970).

A method is outlined for the determination of lead-210 and polonium-210 in seawater by solvent extraction, followed by electrodeposition and alpha counting. Data are given for the lead-210 and polonium-210 content of twenty-nine samples collected at a depth of 20 m in the sea around the Cape of Good Hope during March 1969. The mean activities of lead-210 and polonium-210 in these seawater samples were 38×10^{-15} c/l and 20×10^{-15} c/l, respectively. Real variations in the concentrations of these nuclides were found to exist, and these could in part be ascribed to different water masses and current systems. The lead-210 and polonium-210 contents of eleven zooplankton and three phytoplankton samples collected during the same period were also determined. Mean values for lead-210 and polonium-210 in zooplankton were 33 pc/kg wet weight and 399 pc/kg wet weight, respectively. A correlation between these nuclides in zooplankton was found to exist, the lead-210 activity being on the average one twelfth of the polonium-210 activity. An attempt has been made to evaluate the biogeochemical balance of lead-210 and polonium-210 in the marine environment. Using the data presented, and making certain stated assumptions, the removal times of these nuclides from the upper mixed layer have been calculated. These times were found to be about 5 yr for lead-210 and 0.6 yr for polonium-210. (auth) (UK)

Activation Procedures

Refer also to abstracts 36263 and 37010.

36183 (RT/CHI-(70)13) RARE EARTHS DETERMINATION IN URANIUM MATRICES BY NEUTRON ACTIVATION ANALYSIS. Mosauro, A.; Di Stefano, I. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). Mar 1970. 22p. Dep. CFSTI (U. S. Sales Only).

Neutron activation analysis is particularly suitable for determination of rare earth traces in uranium matrices because of its higher sensitivity in comparison with other analytical methods. Furthermore the application of a Ge(Li) detector allowed the simultaneous determination of Ce, Dy, Eu, La, Lu, Sm, and Yb; the matrix was chromatographically separated before neutron activation. (auth)

36184 SUBSTOICHIOMETRIC DETERMINATION OF TRACES OF PALLADIUM BY NEUTRON ACTIVATION ANALYSIS. Briscoe, G. B.; Humphries, S. (Univ. of Aston, Birmingham, Eng.). Talanta; 17: 371-80(May 1970).

A highly selective, rapid one-step radiochemical separation procedure for palladium was developed. It is based on the solvent extraction of palladium diethyldithiocarbamate from a 5M hydrochloric acid solution with a substoichiometric amount of copper diethyldithiocarbamate in chloroform. The separation was applied to the determination of traces of palladium by neutron activation analysis, in platinum, the rocks W-1 and PCC-1, and a biological material (kale). Amounts of palladium down to 10^{-9} g were determined. (auth) (UK)

36185 PHYSICAL PRINCIPLES OF ACTIVATION ANALYSIS WITH CHARGED PARTICLES. Krasnov, N. N. This paper was summarized in At. Energ. (USSR); 26: 284-5(Mar 1969) as paper No. 269. (In Russian).

Using the concept of isotope yield and an approximation for the range-energy relation, the basic formulas were obtained for determination of impurities in thick targets and thin foils with both absolute and relative measurement techniques. It is shown that it is possible to determine simultaneously admixtures of various elements from which a single isotope results. (M.C.G.)

36186 DETERMINATION OF Co, Cu, Fe, Ga, W, AND Zn IN ROCKS BY NEUTRON ACTIVATION AND ANION-EXCHANGE SEPARATION. Johansen, O.; Steinnes, E. (Institutt for Atomenergi, Kjeller, Norway). Talanta; 17: 407-14(May 1970).

A neutron-activation method for the simultaneous determination of cobalt, copper, gallium, iron, tungsten, and zinc in rocks is described. The method is based on anion-exchange separation in hydrochloric acid media. Chemical yield is higher than 97% for all elements, except for tungsten, where the recovery of the carrier is established by re-activation. The precision is about 1.3% for the iron determination and about 3% for cobalt, copper, gallium, and zinc. (auth) (UK)

36187 RAPID DETERMINATION OF ALUMINUM IN PHARMACEUTICAL DOSAGE FORMS BY NEUTRON ACTIVATION. Lambert, Joseph P. F.; Margosis, Michel (National Center for Antibiotics and Insulin Analysis, Washington, D. C.). J. Pharm. Sci.; 59: 1005-7(Jul 1970).

A rapid, efficient, and highly accurate assay by neutron activation analysis is presented for aluminum content as a function of the aluminum compounds contained in complex antibiotic formulations. The assay requires no chemical isolation or cleanup. The relatively short half-life of ^{28}Al allows rapid analysis, and the technique favors the detection of aluminum over possible interferences by longer lived radionuclides. (auth)

36188 NEUTRON ACTIVATION ANALYSIS FOR SMALL AMOUNTS OF TANTALUM. Grinberg, L. L. This paper was summarized in At. Energ. (USSR); 27: 51(Jul 1969) as paper No. 318/5194. (In Russian).

A variant of neutron activation analysis for Ta through the isotope ^{182}Ta and separation by coprecipitation with MnO_2 is proposed. (M.C.G.)

36189 TOTAL AND EXCHANGEABLE SODIUM STUDIES IN SWINE AND SHEEP USING ACTIVATION ANALYSIS AND ISOTOPIC DILUTION. Johnson, D. R. (Oak Ridge National Lab., Tenn.); Poston, J. W.; Auxier, J. A.; Brown, D. G.; Gramly, W. A.; Gibbs, W. D.; Hodges, Harold D.; Davy, D. R. Health Phys.; 18: 729-31(Jun 1970).

The doubt surrounding the accuracy of the figure of 105g of sodium per 70 kg standard man as reported by ICRP is discussed. To resolve this doubt a study was undertaken to investigate exchangeable and total body sodium in large animals. To determine total sodium content whole body neutron irradiation and subsequent counting was carried out. Factors affecting the accuracy of whole body counting are discussed. The average result was 119 (for swine) and 139 (for sheep) g Na per 70 kg body weight. Exchangeable sodium was determined by isotopic dilution and found to be 80 (for swine) and 68.5 (for sheep) g per 70 kg body weight. It is suggested that not all body Na is exchangeable and that, at least for swine and sheep, total Na content is more than 105 g per 70 kg of body weight. (UK)

36190 DETERMINATION OF GERMANIUM IN HIGH-PURITY IRON AND ALUMINUM BY NEUTRON ACTIVATION ANALYSIS. May, Serge; Samadi, Ali Afzal (CEA de Saclay, Gif-sur-Yvette, France). Bull. Soc. Chim. Fr.; No. 4, 1628-31(Apr 1970). (In French).

The nuclear reaction used is the following: $^{70}Ge(\eta,\gamma)\ ^{71}Ge(^{71}Ge$ isotopic abundance : 20,55%; σ : 3,4 b; ^{71}Ge half-life : 11.4 days x ray : 10 keV). The experimental sensitivity is on the order of 10^{-2} μg. The sample was irradiated in the OSIRIS reactor for 3 days in a 10^{14} n x cm^{-2} x s^{-1} flux. After 5 days, Ge was isolated by chemical processes such as precipitation, ion exchange and solvent extraction. Ge was determined as a chloride and counted with the help of a liquid scintillation counter. The analysis results show that the Ge contents of Fe vary from 6×10^{-3} to 1, 4 ppM according to the purity of the sample and the Ge contents of Al lie between 4×10^{-3} and 6×10^{-2} ppM. (France)

36191 SIMULTANEOUS DETERMINATION OF COPPER, MANGANESE, AND ZINC IN BIOLOGICAL MATERIALS BY MEANS OF NEUTRON ACTIVATION ANALYSIS AND CHELATE EXTRACTION. Wesch, H.; Zimmerer, J.; Schuhmacher, J. (Deutsche Krebsforschungszentrums, Heidelberg). Int. J. Appl. Radiat. Isotop.; 21: 431-3(Jul 1970).

The determinations were carried out by metal ion chelation using ammoniumpyrolidindithiocarbamate (APDC) followed by a two phase extraction by methyl isobutyl ketone (MIBK). The Cu, Mn, and Zn were extracted quantitatively into the organic phase, while the disturbing elements Na, K, P, Cl, and Br remained in the aqueous phase or were removed by wet ashing. Centrifugation then gave a sharp phase separation of Cu, Mn, and Zn. Experimental details are given. The dependence of the extraction from a liver preparation on the pH of the solution is illustrated graphically and the γ spectra of a tumor sample shown before and after chelation of the wet ashed sample Mn values for a rat liver sample are given and the plasma Cu value for 5 rats tabulated. (UK)

36192 DETERMINATION OF ALUMINA IN SINTERED ALUMINUM POWDER BY ACTIVATION WITH 14-MeV NEUTRONS. Espanol, Carlos E.; Marafuschi, Ana Maria (Univ., Buenos Aires). Talanta; 17: 653-8(Jul 1970).

Fast neutrons of 14 MeV produced in the IMICAM CISE 150-kV generator by the (d,t) reaction in a tritium–titanium target were used in the indirect determination of Al_2O_3. The samples were irradiated for 30 sec and the total ^{16}N activity was determined by counting for ten 2-sec periods and graphically integrating. The standards were a known sintered aluminum powder and nylon pieces of identical shape. The method is competitive with the chemical one because of its quickness, sensitivity and precision. (auth) (UK)

36193 ENVIRONMENTAL VARIATION OF ARSENIC LEVELS IN HUMAN BLOOD DETERMINED BY NEUTRON ACTIVATION ANALYSIS. Heydorn, K. (Research Establishment Risoe, Roskilde, Denmark). Clin. Chim. Acta; 28: 349-57(1970).

Arsenic levels in blood plasma and red cells from patients with Blackfoot disease, a peripheral arteriosclerosis endemic to a small area in Taiwan, were studied in relation to healthy individuals from the same and other parts of Taiwan and compared with arsenic levels in a control group from Denmark. Arsenic was determined by neutron activation analysis with radiochemical separation and re-irradiation yield determination. The precision and accuracy of the results were carefully evaluated in order to permit quantitative tests for the significance of the observed differences. The results from Taiwan followed a logarithmic normal distribution, and no difference was found between Blackfoot patients and their healthy family members. However, their overall arsenic levels were higher than the Taiwan average, presumably because of arsenic in their drinking water. Much lower levels were found in Denmark, which geochemically belongs to a soil zone with less arsenic than Taiwan. (auth)

Inorganic, Organic, and Physical Chemistry

Refer also to abstracts 36151, 36263, 36278, 36329, 36336, 36344, 36348, 36356, 36402, 36981, 37002, 37583, and 38512.

36194 (APDA-241) SOLUBILITY OF HYDROGEN IN SODIUM. Meacham, S. A.; Hill, E. F.; Gordus, A. A. (Atomic Power Development Associates, Inc., Detroit, Mich.). Jun 1970. Contract AT(11-1)-865. 58p. Dep. CFSTI.

The solubility of hydrogen in liquid sodium was determined using a closed-cell technique that was found to be superior to previous methods. The variables studied were hydrogen pressure (10^{-4} to 25 cm Hg), temperature (290°C to 400°C), and the oxygen content of the sodium (7 to 25 ppM). Plots of $P^{\frac{1}{2}}$ of hydrogen versus parts per million of hydrogen dissolved in sodium were linear at pressures above 0.1 cm Hg, the slopes being equal to approximately 14.8 ppM dissolved hydrogen $\times (P_{cm\ Hg})^{-\frac{1}{2}}$. An additional phase (NaH solid solution) can be formed at each temperature resulting in an invariant system. The temperature dependencies of the hydrogen pressure and the hydrogen solubility of these saturated solutions were almost identical for sodium solutions containing 7 and 25 ppM dissolved oxygen and are described by the equations, $\log P_{H_2(cm)}$ at saturation = (6400/T(K°)) + 10.82 and log ppM dissolved hydrogen at saturation = –(3180/T(K°)) + 6.52, respectively. (auth)

36195 (CEA-N-1293) MEASUREMENTS OF THE VISCOSITY OF SOME GASEOUS FLUORINE COMPOUNDS. Ostorero, Jean (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Apr 1970. 36p. (In French). Dep. CFSTI (U. S. Sales Only).

The viscosities of the following gases: H_2, He, Ar, CH_4, F_2, HF, ClO_3F, MoF_6, WF_6, UF_6, ClF, ClF_3, ClF_5, BrF_3, BrF_5, were measured over the temperature range 50 to 150°C. Measurements were made with a corrosion-resisting capillary viscometer. From the experimental data obtained, the parameters σ, (ϵ/k) of the 6-12 Lennard–Jones potential (nonpolar gases) and μ, σ, (ϵ/k) of the 3-6-12 Stockmayer potential (polar gases) were calculated. (auth) (France)

36196 (DP-Report-72) LITERATURE SURVEY ON CARBON DEPOSITION FROM CARBON MONOXIDE. Project DRAGON. Coen, F. (Atomic Energy Establishment, Winfrith (England)). Dec 1961. 17p. Dep. CFSTI.

Results from studies of the catalytic decomposition of carbon monoxide are discussed in the following order: the reaction rate as a function of temperature and time; inhibiting or activating effect of some compounds or gases; and the form of the deposited carbon. Data on the carbon deposition from carbon monoxide–hydrogen mixtures with iron, nickel, or stainless steel as catalyts are also examined. It was concluded that the catalytic deposition of carbon takes place in the temperature range of 400 to 750°C with maximum rate occurring between 500 and 600°C. The effect of hydrogen was found to be a function of its partial pressure in the system. If hydrogen is present in small percentages, it has an activating effect on carbon deposition; however, if it is present in large amounts, it reacts with carbon monoxide to form methane, but there may also be some carbon deposition. (D.H.M.)

36197 (DP-Report-73) REACTION OF CONVENTIONAL DRAGON FUEL INSERTS IN THE HEAT TREATED CONDITION WITH MOISTURE. Project DRAGON. Marengo, G. (Atomic Energy Establishment, Winfrith (England)). Dec 1961. 14p. Dep. CFSTI.

Conventional Dragon fuel inserts contain uranium and thorium dicarbides, which are very reactive with moisture. During fabrication it is necessary to maintain an inert atmosphere. Experiments to determine the maximum permissible moisture content are described. It was concluded that 50 vpM is the highest allowable level of moisture in the nitrogen atmosphere. (auth)

36198 (DP-Report-85) ADSORPTION ERRORS IN THE SAMPLING OF GASES. Project DRAGON. Voice, E. H. (Atomic Energy Establishment, Winfrith (England)). Jan 1962. 14p. Dep. CFSTI.

The problem of assessing the amount of adsorption by the container of the gases to be sampled is discussed in detail. It is concluded that experiments to check the reliability of the proposed long sampling lines for DRAGON are essential. (auth)

36199 (IS-T-381) STABILITY CONSTANTS OF SOME CARBOXYLATE COMPLEXES OF THE TRIVALENT LANTHANONS. Devine, Christopher Duncan (Ames Lab., Iowa). 1969. Contract W-7405-eng-82. 163p. Dep. CFSTI.

Thesis.

The stoichiometric stability constants of the complexes formed by the trivalent rare earth ions with the 2,2-bis(hydroxymethyl)-propionate and α-hydroxyisobutyrate anions were measured at 25° and an ionic strength of 0.1000 M using $NaClO_4$ as a supporting electrolyte. The method of competing reactions was used for the study, and twenty sample solutions were prepared for each metal–ligand system studied. The pH of each sample was measured with a Beckman model 1019 pH meter. The stability constants were calculated by means of a weighted least squares program using an IBM-360 computer. A variable acid dissociation constant was used in the calculations. The relation between the stability constants and rare earth ionic radius was found to be remarkably different for each of the ligands studied. In order to account for this fact and for other features of the data, a theory of rare earth complex formation was proposed. It was suggested that the trends in the stability of the rare earth 2,2-bis(hydroxymethyl)propionate complexes primarily reflected the varying degrees of hydration of the rare earth ions. The trends in the stability of the rare earth α-hydroxyisobutyrate complexes were thought to result from a change in the dentate character of the ligand as well as from changes in the degree of cationic hydration. The ratios of successive step formation constants were used to predict the structure of the complexes. The α-hydroxyisobutyrate ligand appeared to bond the lighter rare earth ions tridentately and the heavier rare earth ions bidentately, while the 2,2-bis(hydroxymethyl)propionate ligand appeared to bond tridentately throughout the rare earth series. (101 references). (auth)

36200 (LIB/Trans-213) ISOTOPIC EXCHANGE BETWEEN MOLECULAR HYDROGEN AND LIQUID AMMONIA CATALYSED

BY THE ALKALINE AMIDES. Delmas, Robert (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Translated by R. J. Holmes (Australian Atomic Energy Commission Research Establishment, Lucas Heights), from report CEA-R-3377. 97p. Dep. CFSTI (U. S. Sales Only). Thesis.

The reaction $NH_3 + HD \rightleftharpoons NH_2D + H_2$ (homogeneous and first order with respect to dissolved hydrogen concentration) is catalyzed by alkaline amides. Precise kinetic measurements with amides of sodium, potassium, rubidium, and cesium showed the exchange rate to be proportional to the concentration of the free amide ion. Salt dissociations were calculated using the Fuoss–Onsager equation. Primary salt effects were negligible and the rate equation could be expressed solely as a function of concentrations. Studies of common ion effects and secondary salt effects also support the conclusion that the free amide ion is the only catalytic species. An associative mechanism is proposed. (Australia)

36201 (MLM-1747(TR)) FUNDAMENTAL ASPECTS OF PLUTONIUM CHEMISTRY. II. OXIDATION STATES OF THE ELEMENT. Perez-Bustamante, J. A. Translated for Mound Lab., Miamisburg, Ohio, from Energ. Nucl. (Madrid); 13: 23-45 (1969). 56p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 23: 45296.

36202 (NP-18259) ANNUAL REPORT, 1968-69. (Commonwealth Scientific and Industrial Research Organization, Clayton (Australia). Div. of Chemical Physics). 37p. Dep. CFSTI (U. S. Sales Only).

Research progress is reported under the following topics, general, spectroscopy, mass spectroscopy, electron diffraction, electron microscopy, x-ray diffraction, solid-state chemistry, theoretical chemistry, instruments and engineering services, and service and collaborative work. (D.H.M.)

36203 (NP-18284) DETERMINATION OF THE FIRST HYDROLYSIS CONSTANT FOR TRIVALENT ELEMENTS OF THE SERIES "4f" AND "5f". Desire, Bernard (Paris Univ. (France). Faculte des Sciences). 1970. 45p. (In French). Dep. CFSTI (U. S. Sales Only).

Thesis.

The first hydrolysis constants were determined for elements of the series 4f (Sm, Eu, Gd, Tb, and Dy) and 5f (Am, Cm, Bk, and Cf). The elements were extracted by solvent as chelates. The noncomplexing aqueous phases used were solutions (ClO_4^-, Li^+, H^+) with an ionic strength equal to 0.1 and the organic phases were benzene solutions (except for Gd). The values of log K1 (K1 = $(MOH^{2+})(H^+)/(M^{3+})$), the pH range where M^{3+} ions are predominant and the concentrations in elements present in aqueous medium are given. The hydrolytic behavior of the lanthanide series cannot be explained by a simple electrostatic theory. A decrease of K1 can be observed when the ionic radius decreases, with a sharp discontinuity for the gadolinium ($4f^7$). The values of log K1 are found to increase slightly with Z for Am, Cm, Bk, and Cf. A less important discontinuity is also observed for Cm ($5f^7$). The difference of the hydrolytic properties in both series comes from a behavioral difference between the electrons 4 f strongly attracted by the orbitals 5 s and 5 p and the electrons 5 f less attracted. The ionic potential of the cations M^{3+} cannot determine completely their acidity which increases in this order: $Gd^{3+} < Am^{3+} \sim Cm^{3+} < BK^{3+} < Cf^{3+} < Dy^{3+} < Tb^{3+} < Eu^{3+} < Sm^{3+}$. (auth) (France)

36204 (ORNL-4586) REACTOR CHEMISTRY DIVISION ANNUAL PROGRESS REPORT FOR PERIOD ENDING MAY 31, 1970. (Oak Ridge National Lab., Tenn.). Jul 1970. Contract W-7405-eng-26. 144p. Dep. CFSTI.

Progress is reported in seven sections and a separate abstract was prepared for each section. (M.C.G.)

For abstracts of individual sections see: 36205–36207, 36355, 36356, 37002, and 37003.

36205 (ORNL-4586, pp 1-32) MOLTEN SALT CHEMISTRY. (Oak Ridge National Lab., Tenn.).

Research progress is reported on: fluoride systems, electrochemical studies, noble metal fluorides, structural studies, oxide–fluoride systems, and fluoroborates. (M.C.G.)

36206 (ORNL-4586, pp 33-49) DIRECT SUPPORT FOR THE MOLTEN SALT REACTOR EXPERIMENT. (Oak Ridge National Lab., Tenn.).

Fuel and coolant chemistry and fission product distribution and behavior are discussed. (M.C.G.)

36207 (ORNL-4586, pp 67-86) AQUEOUS SYSTEMS. (Oak Ridge National Lab., Tenn.).

Research progress is reported on water technology in reactors, desalination studies, high-temperature studies, surface chemistry, and other studies in aqueous solutions. (M.C.G.)

36208 (PAEC(A)IN-624(Suppl.1)) PHOSPHORUS ISOTOPES ^{32}P. A Literature Search. (Philippine Atomic Energy Commission, Manila). Dec 1968. 183p. Dep. CFSTI (U. S. Sales Only).

The 1,104 entries are listed under the following headings: biology and medicine; chemistry; engineering; geology; meteorology and mineralogy; health and safety; instrumentation; isotope technology; waste disposal and processing; and general and miscellaneous. The references cited appeared in NSA covering the period January, 1962, to December, 1967. Personal author and corporate author indexes are included. (W.H.K.)

36209 (USC-113-P-21-X-2) ESR STUDIES ON THIYL FREE RADICALS IN RELATION TO BIOLOGICAL EFFECTS OF RADIATION. Progress Report. Wolf, Walter (University of Southern California, Los Angeles). 1 Mar 1970. Contract AT(11-1)-113. 43p. Dep. CFSTI.

The overall purpose of the present project is to study the ESR characteristics of thiyl and related free radicals, in order to achieve a better understanding of the role of mercapto-containing compounds, both in radiation damage and radiation protection processes. The oxidation of thiols with ceric ion, in solution, leads to a number of free radical signals, ascribable to at least 6 different species. Some of them, like the RS·, were conclusively identified, while others were only tentatively assigned (RSO_2· and RO·). Three other signals defy, at this time, even tentative assignment. Correlations between the coupling constants and structure suggest possible means of identifying free radical sites, of potential interest for polypeptide and protein studies. At this time, the ceric ion remains the most versatile oxidizing system; attempts to use other homogeneous or heterogeneous phase one-electron transfer agents were unsuccessful. Attempts are presently under way to build a uv laser, which would be capable of generating a high concentration of free radicals directly in the cavity. If this gas laser works as expected, it would be possible to produce selected photochemical reactions by varying the wavelength used. Of particular interest is the hydrogen transfer reaction observed in mercaptoethanol, which might prove to be an interesting model system for the study of radical site migrations. (auth)

36210 REACTIONS OF THE OXIDES OF NIOBIUM WITH LIQUID POTASSIUM. Addison, C. C.; Barker, M. G.; Lintonbon, R. M. (Univ. of Nottingham, Eng.). J. Chem. Soc., A; No. 9, 1465-9(1970).

The reactions of the oxides Nb_2O_5, NbO_2, and NbO with liquid potassium were studied at temperatures of 400°C (Nb_2O_5) and 600°C (all three). Reaction products are black, hygroscopic powders, which were examined by x-ray powder crystallography. In each case the equilibrium products proved to be niobium metal and a low-temperature form of potassium orthoniobate, K_3NbO_4. The latter was also prepared in a pure state, and its x-ray powder diffraction pattern defined. The coexistence of niobium in the Nb^0 and Nb^V states in the product is discussed in the light of possible reaction mechanisms, and the stability of the MO_4^{3-} species in the liquid metal. Potassium monoxide also reacts with niobium metal at 260°C to give K_3NbO_4. (auth) (UK)

36211 ^{14}C ISOTOPIC EFFECTS IN ALKALINE HYDROLYSIS AND SOLVOLYSIS OF 1,1,2-TRIPHENYL-2-BROMOETHANOL. Laureilla D, J.; Laurent, E.; Laurent, A. Tetrahedron Lett.; No. 25, 2151-4(May 1970). (In French).

This compound under different conditions undergoes (1) alkaline hydrolysis to epoxide (an SN2 reaction), (2) solvolysis to ketone plus glycol (either SN1 or SN2). Cumulative measurement of the product after a short period of reaction (1) and of the reactant after near-completion of reaction (2), using chromatography, showed that in reaction (2) both types of process occur with comparable rates. Results for reaction (1) were indecisive. (UK)

36212 THIRD-BODY COEFFICIENTS OF H_2O AND D_2O IN THE $H_2 + O_2$ AND $D_2 + O_2$ REACTION. Baldwin, R. R.; Moyes, R. B.; Rossiter, B. N.; Walker, R. W. (Hull Univ., Eng.). Combust. Flame; 14: 181-90(Apr 1970).

The effect of H_2O and of D_2O on the second limit of the $H_2 + O_2$ and $D_2 + O_2$ reactions in KCl-coated and aged boric acid-coated vessels was used to obtain the coefficients (relative to $H_2 = 1$) $m_{H_2O} = 6.4 \pm 0.3$ and $m_{D_2O} = 4.9 \pm 0.3$ in the reaction: $H + O_2 + M = HO_2 + M$, and the coefficients (relative to $D_2 = 1$) $m\beta_{H_2O} = 10.3 \pm 0.5$, $m\beta_{D_2O} = 8.85 \pm 0.5$ in the reaction: $D + O_2 + M = DO_2 + M$. These values provide no support for the suggestion that the high efficiency of H_2O in the reaction $H + O_2 + M$ arises from a near coincidence of the vibrational frequencies of H_2O and the newly formed HO_2, which facilitates vibrational–vibrational energy exchanges. (auth) (UK)

36213 EFFECT OF ISOTOPIC SUBSTITUTION ON THE DECOMPOSITION FLAME OF HYDRAZINE. Gray, P.; Holland, Susan (Univ. of Leeds, Eng.). Combust. Flame: 14: 203-16 (Apr 1970).

The mode of decomposition of hydrazine in the low-pressure flame was investigated by a comparison of flame speeds for the N_2D_4 system with those of the previously investigated N_2H_4 system. Measurements were made using a closed-vessel technique, whereby flame speeds relative to the burned gas were determined by schlieren photography. For pure N_2D_4, flame speeds were measured at an initial temperature of 62°C in the pressure range 20 to 70 torr. In this region flame speed was virtually pressure independent, indicating an overall reaction order of 2. The comparison was extended by measuring flame speeds for binary mixtures containing inert diluents. Increasing amounts of two diluents, argon and nitrogen, were added to a fixed partial pressure (50.2 torr) of N_2D_4, and flame speed was measured over the entire flammability range. The effect of the added diluents was to decrease the flame speed with increasing partial pressure of diluent, and to extinguish the flame when the concentration of diluent exceeds ca. 50%. The effective activation energy was estimated from the dependence of flame speed on temperature for diluted mixtures. It is estimated to be 35 ± 2 kcal $mole^{-1}$, based on calculated values of adiabatic flame temperature and thermal conductivity, assuming a stoichiometry identical to that for N_2H_4 decomposition. A large isotope effect of flame speed was apparent when the present results are compared directly with those of a previous investigation of the N_2H_4 flame, obtained in the same apparatus and under the same initial conditions. The speed of the hydrazine decomposition flame was halved when deuterium was substituted for hydrogen. This decrease in flame speed is explained in terms of transport properties, equilibrium thermodynamics, and kinetic factors. Isotopic changes in thermal conductivity contribute a factor of 1.1 to the total effect; isotopic changes in adiabatic flame temperature contribute a factor of 1.3 to 1.5; and kinetic isotope effects (k_H/k_D) contribute a factor of 1.5. The results were applied to test the validity of two possible modes of hydrazine decomposition: by a chain reaction and by a unimolecular reaction in the falloff region. Both mechanisms show inconsistencies with the present measurements, and it is impossible to eliminate unambiguously either possibility. The present evidence, however, favors the chain reaction. (auth) (UK)

36214 SECONDARY DEUTERIUM ISOTOPE EFFECTS IN THE 1,3-DIPOLAR CYCLOADDITION OF TETRACYANOETHYLENE OXIDE TO STYRENE. Bayne, William F. (Bryn Mawr Coll., Pa.); Snyder, Eugene I. Tetrahedron Lett.; 26: 2263-6(Jun 1970).

The title reaction was studied using mixtures of light styrene and each of the monodeuterated styrenes competing for 0.1 mole equivalent of tetracyanoethylene oxide in solutions of 1,2-dibromoethane at 125°. (auth) (UK)

36215 DEUTERIUM ISOTOPE EFFECT FOR THE BORON TRIFLUORIDE CATALYSED REARRANGEMENT OF 2-METHYL-1,2-EPOXYPROPANE. Blackett, B. N.; Coxon, J. M.; Hartshorn, M. P.; Richards, K. E. (Canterbury Univ., Christchurch, N. Z.). Aust. J. Chem.; 23: 839-40(Apr 1970).

The primary deuterium isotope effect for the hydride (deuteride) shift in the epoxide–aldehyde reaction was ascertained as ~2 since M_H/M_D (neglecting secondary isotope effects) equals 1.92. (Australia)

36216 COMPLEX COMPOUNDS OF URANIUM HEXAFLUORIDE WITH ALKALI METAL FLUORIDES. COMMUNICATION II. CESIUM HEPTAFLUOROURANATE $CsUF_7$. Sadikova, A. T.; Sadikov, G. G.; Nikolaev, N. S. This paper was summarized in At. Energ. (USSR); 26: 283-4(Mar 1969) as paper No. 268. (In Russian).

An x-ray diffraction study was made on $CsUF_7$, which was produced by isolation from a solution of CsF and UF_6 at 200 to 220°C. The crystals have cubic symmetry and a = 5.51 ± 0.01 Å. The density is 5.05 g/cm^3 and one formula unit corresponds to the unit cell. (M.C.G.)

36217 VOLATILE CHELATES OF QUADRIVALENT ACTINIDES. Swain, H. A. Jr.; Karraker, D. G. (E. I. Du Pont de Nemours and Co., Aiken, S. C.). Contract AT(07-2)-1. Inorg. Chem.; 9: 1766-9(Jul 1970).

Tetrakis β-diketonates were synthesized with quadrivalent thorium, uranium, neptunium, and plutonium and 1,1,1,2,2,3,3-heptafluoro-7,7-dimethyloctane-4,6-dione (fod) and with Th^{4+} and U^{4+} and 2,2,6,6-tetramethylheptane-3,5-dione (thd) and then characterized by elemental analysis. X-ray diffraction data showed $Th(fod)_4$, $U(fod)_4$, and $Np(fod)_4$ were isomorphous, but $Pu(fod)_4$ had a different structure. Vapor pressures measured by a modified Knudsen effusion method were ca. 10^{-3} mm at 125° for all fod chelates and at 195° for both thd chelates. ΔH_{subl} increased from 33.1 kcal/mole for $Th(fod)_4$ to 36.4 kcal/mole for $Pu(fod)_4$. ΔS_{subl} values increased nearly linearly with Z for Th^{4+}, U^{4+}, and Np^{4+} fod chelates; the value for ΔS_{subl} for $Pu(fod)_4$ was larger than the value predicted by a linear increase with Z, probably because of the different crystal structure of $Pu(fod)_4$. (auth)

36218 ^{13}C KINETIC ISOTOPE EFFECTS. V. SUBSTITUENT EFFECTS ON k_{12}/k_{13} FOR ALCOHOLYSIS OF 1-PHENYL-1-BROMOETHANE. Bron, Jan; Stothers, J. B. (Univ. of Western Ontario, London). Can. J. Chem.; 47: 2506-9(1 Jul 1969).

As a test of earlier interpretations of the ^{13}C kinetic isotope effects found for alcoholysis of 1-phenyl-1-bromoethane, the effect of the p-methyl and p-bromo substituents on ^{13}C fractionations in ethanol and methanol were investigated. Isotopic fractionation at the α-carbon was found to be substituent dependent, and the observed trend is consistent with the proposal that stabilization of the cationic center by the phenyl ring is a major factor governing the isotope effect in these systems. The first example of an inverse primary kinetic isotope effect for carbon ($k_{12}/k_{13} < 1$) is described. (auth) (Canada)

36219 EFFECT OF PRESSURE ON THE INTRAMOLECULAR AND INTERMOLECULAR CONTRIBUTIONS TO DIPOLAR SPIN RELAXATION IN BENZENE AND CHLOROBENZENE IN THE LIQUID STATE. Bull, T. E.; Jonas, J. (Univ. of Illinois, Urbana). J. Chem. Phys.; 52: 4553-8(1 May 1970).

The pressure dependence of the proton spin-lattice relaxation times was measured at 23°C in liquid benzene and its mixtures with benzene-d_6 up to 600 bar, and in liquid chlorobenzene and its mixtures with chlorobenzene-d_5 up to 2000 bar. The separation of the intramolecular and intermolecular contributions to proton dipolar relaxation made it possible to study the effect of pressure on the reorientational and translational motions of the molecular liquids investigated. As predicted by the Bloembergen–Purcell–Pound (BPP) theory the intermolecular T_1 were found to follow the changes in the viscosity with pressure. On the other hand, the experimental pressure dependence of the intramolecular T_1 in benzene differs widely from the BPP theoretical prediction due to the relatively free rotation about the C_6 axis in benzene. Removal of the C_6 axis and introduction of a dipole in chlorobenzene result in agreement between theoretical and experimental intramolecular T_1 pressure dependences. As an example of a molecule with internal rotation some of the previous results on acetone were also discussed. The results of this study show that molecular symmetry plays an important role in determining how well the Debye–BPP model describes the rotational motion. From molecular symmetry one can also infer on the degree of coupling between rotational and translational motions in liquids. Activation volumes for the intramolecular and intermolecular T_1 were calculated and compared with corresponding activation energies. $(\Delta V^{\ddagger})_{intra} \ll (\Delta V^{\ddagger})_{inter}$ in benzene and acetone, whereas $(\Delta V^{\ddagger})_{intra} (\Delta V^{\ddagger})_{inter}$ in chlorobenzene. The data obtained also indicate that in many cases the activation volumes are pressure dependent. (auth)

36220 VISCOSITIES OF SOLUTIONS OF POTASSIUM IN LIQUID AMMONIA AND DEUTEROAMMONIA. Hutchison, Clyde A. Jr.; O'Reilly, Donald E. (Univ. of Chicago). J. Chem. Phys.; 52: 4400-3(1 May 1970).

The viscosities of solutions of potassium in liquid ammonia and deuteroammonia were measured with an Ostwald viscosimeter at −33.6, 0.0, and +20.0°C over a concentration range from zero to approximately 1.5 mole $liter^{-1}$. The methods of measurement and the experimental results are given. The viscosities η of the pure liquids, measured in centipoise, are least-squares fitted by the relations $\log_e\eta = -4.677 + 1.577/RT$ for ammonia and $\log_e\eta = -4.676 + 1.670/RT$ for deuteroammonia, in which R is the gas constant and T is the Kelvin temperature. (auth)

36221 ION-POLAR-MOLECULE REACTIONS: ENERGY DEPENDENCY OF HYDROGEN ATOM AND ION TRANSFER IN THE METHANOL–ACETALDEHYDE SYSTEM. Leger, L. J. (Univ. of Houston, Tex.); Meisels, G. G.; Tiernan, T. O. J. Chem. Phys.; 52: 4319-24(1 May 1970).

A tandem mass spectrometer was employed to investigate hydrogen atom, hydrogen ion, and charge transfer in collisions involving specifically deuterium-labeled methanol and acetaldehyde and their molecular ions at energies between 1 and 7 eV (laboratory system). At the lowest incident ion energies, hydrium transfer is preferred from the electronegative group, while randomness is approached at higher energies. Ion transfer is the most important process at all energies, and transfer of the hydrogen ion from the electronegative group is always favored. The nonrandomization of equivalent atoms in a possible complex suggests that the ion retains its identity in the reaction. Both the atom and the ion

transfer show a marked isotope effect. These results are interpreted by charge localization in the reactant ion and a direct mechanism in which long-range forces are important. (auth)

36222 SINGLE VIBRONIC LEVEL FLUORESCENCE. II. VAPOR-PHASE FLUORESCENCE SPECTRA FROM THE ZERO-POINT LEVEL OF $^1B_{2u}$ BENZENE AND BENZENE-d_6. Parmenter, C. S.; Schuyler, M. W. (Indiana Univ., Bloomington). J. Chem. Phys.; 52: 5366-74(15 May 1970).

Flourescence spectra have been obtained at 300°K from C_6H_6 and from C_6D_6 vapor at 0.1 torr in which all emitting molecules were in the zero-point vibrational level of the $^1B_{2u}$ state. Analysis of the spectra was completed using selection rules appropriate for D_{2h} symmetry of both the ground ($^1A_{1g}$) and excited ($^1B_{2u}$) states. The spectra were compared with the zero-point fluorescence obtained by the conventional method of matrix isolation of benzene at 77°K. The forbidden transitions seen in the latter were absent in isolated molecule gas-phase spectra. The zero-point spectra were also compared with that from a 300°K Boltzmann distribution of $^1B_{2u}$ vibronic levels. (auth)

36223 KINETIC ISOTOPE EFFECT FOR THE THERMALLY INDUCED MIGRATION OF HYDROGEN IN CYCLOPENTADIENES. McLean, S.; Webster, C. J.; Rutherford, R. J. D. (Univ. of Toronto). Can. J. Chem.; 47: 1555-9(1 May 1969).

The Arrhenius parameters were obtained for the rearrangement of 5-methylcyclopentadiene by a 1,2-hydrogen migration and for the corresponding rearrangement of 5-methylpentadeuteriocyclopentadiene. The results, taken in conjunction with those reported previously, allow the effect of the methyl group on the rate of hydrogen migration to be assessed. The kinetic isotope effect is of particular interest because the hydrogen transfer takes place through a transition state that is unequivocally non-linear. (auth) (Canada)

36224 ISOTOPE SHIFT STUDIES AND MULTIPLET ANALYSIS OF SYSTEM I OF FeCl. Rao, D. V. K.; Rao, P. Tiruvenganna (Andhra Univ., Waltair, India). J. Phys., B (London); 3: 878-81 (Jun 1970).

System I ($^6\Pi-^6\Sigma$) of the FeCl molecule was reinvestigated under high dispersion (1.25 Å mm^{-1}). Several band heads were newly classified and the isotope shifts ($\nu Fe^{35}Cl-\nu Fe^{37}Cl$) observed $\Delta v = \pm 1$ sequences of system I confirm the vibrational assignments. The absence of the N and O form heads even in the $\Delta v = O$ sequence is attributed to a tendency towards Hund's case (c) in one or both the states involved. (auth) (UK)

36225 EXPERIMENTS ON CHEMISTRY OF ELEMENT 104: KURCHATOVIUM. V. ADSORPTION OF KURCHATOVIUM CHLORIDE FROM THE GAS STREAM ON SURFACES OF GLASS AND POTASSIUM CHLORIDE. Zvara, I.; Chuburkov, Yu. T.; Belov, V. Z.; Buklanov, G. V.; Zakhvataev, B. B.; Zvarova, T. S.; Maslov, O. D.; Caletka, R.; Shalaevskii, M. R. (Joint Inst. for Nuclear Research, Dubna, USSR). J. Inorg. Nucl. Chem.; 32: 1885-94(Jun 1970).

The adsorption of kurchatovium chloride on surfaces of glass and potassium chloride was studied by a gas-solid chromatographic technique. The compound was shown to be similar in its properties to hafnium tetrachloride. More than 60 kurchatovium atoms were observed in these experiments by their spontaneous fission. (auth) (UK)

36226 MEAN AMPLITUDES OF VIBRATION FOR METHYL KETENE. Cyvin, S. J. (Norges Tekniske Hoegskole, Trondheim, Norway); Christensen, D. H.; Nielsen, O. F. Chem. Phys. Lett.; 5: 597-600(15 Jun 1970).

Mean amplitudes of vibration for methylketene and several of its isotopic molecules, which include deuterium, ^{13}C and ^{18}O substitutions, were calculated. Some remarkable secondary isotope effects are reported for nonbonded CC, CH, and OH distances. (auth)

36227 ELECTRONIC EFFECTS IN SOLVOLYSIS REACTIONS. III. SOLVOLYSIS OF ALLYL-SUBSTITUTED CUMYL DERIVATIVES. Jones, Lee B.; Foster, James P. (Univ. of Arizona, Tucson). J. Org. Chem.; 35: 1777-81(Jun 1970).

Synthetic procedures are described for p-γ, γ-dimethylallyl-, p-α, α-dimethylallyl-, p-3-butenyl-, m-allyl, p-allyl-, and p-γ, γ-dideuterioallylcumyl p-nitrobenzoates. The possibility of allylic participation during the solvolysis of these compounds in aqueous mixtures was investigated. Substituent constants (σ^+), skeletal rearrangement studies, and kinetic isotope effect measurements were employed to determine the nature and extent of such participation. These data, coupled with the uniformity of activation parameters and the absence of skeletal isomerizations, suggest that inductive effects by the allylic double bond are the major influence in the solvolytic behavior of these esters. (auth)

36228 ACID-CATALYZED NITRAMINE REARRANGEMENT. V. THE EFFECT OF ISOTOPIC REPLACEMENT OF AROMATIC RING HYDROGENS. White, William N.; Golden, J. Terrence; Lazdins, Dagnija (Ohio State Univ., Columbus. Univ. of Vermont, Burlington). J. Org. Chem.; 35: 2048-50(Jun 1970).

In order to rule out proton loss as a rate-limiting mechanism in the aromatic nitramine rearrangement and to establish that the amine-nitro group bond was rate limiting, the reactivity of nitramines in which the aromatic hydrogens were replaced by deuterium or tritium was examined. The results of the studies are tabulated, and the substitution of deuterium or tritium at the migration terminus did not affect either the rate of rearrangement or the distribution of products. It is concluded that the proton loss is not a rate determinant. (B.L.M.)

36229 CHRONOPOTENTIOMETRY IN STRONG PHOSPHORIC ACID. II. CHRONOPOTENTIOMETRY OF URANIUM(VI) ION IN STRONG PHOSPHORIC ACID. Goto, Masashi; Ishii, Daido (Nagoya Univ., Japan). Nippon Kagaku Zasshi; 91: 343-6(Apr 1970). (In Japanese).

Chronopotentiometric behavior of uranium(VI) ion in strong phosphoric acid(P_2O_5, 77.8 wt %) as the solvent and supporting electrolyte was investigated at 60 to 120°C using platinum wire electrode. A reduction wave with the quarter time potential, changing with the current density, of about -0.1V(vs. $Hg|Hg_2SO_4$) was observed for uranium(VI). The re-oxidation wave had a quarter time potential of about 0.8 V and its transition time was nearly one-third of the time for reduction wave. An oxidation wave with the quarter time potential equal to the re-oxidation wave of uranium(VI) was observed for uranium(IV). Therefore, it seems that the electrode reaction for the reduction process of uranium(VI) is an irreversible, two-electron transfer; and the product of electrolysis is soluble in strong phosphoric acid. The dependences of transition time on the concentration and current density were studied for the reduction wave, and consequently the Sand equation held good for uranium(VI) in this solvent also. There was a linear relation between the logarithm of the diffusion coefficient calculated from the Sand equation and the reciprocal of absolute temperature. The activation energy from the Arrhenius equation for diffusion process was 11.5 kcal/mole, and the diffusion coefficient was 5.80×10^{-6} cm^2/sec at 100°C in this solvent. The rate constant and transfer coefficient were calculated for the reduction process of uranium(VI). (auth)

36230 DYNAMICALLY INDUCED FORBIDDEN ELECTRIC-DIPOLE TRANSITIONS OF Np^{4+} IN ThO_2. Menzel, E. R.; Gruber, J. B. (Washington State Univ., Pullman). J. Chem. Phys.; 52: 4830-2(1 May 1970).

Forbidden electronic electric-dipole transitions in the optical spectrum of Np^{4+} in the ThO_2 are induced by a dynamic distortion to the O_h symmetry. The resulting dynamic line broadening can be described to a first approximation by an averaged Hamiltonian $B_1\alpha Q_4^2$, which predicts linewidths in reasonably good agreement with experiment for $B_2 = 150$ cm^{-1}. (auth)

36231 CHEMICAL KINETICS OF ENERGETIC ATOMS. IV. Chapin, D. M.; Kostin, M. D. (Princeton Univ., N. J.). J. Chem. Phys.; 52: 5317-21(15 May 1970).

An integrodifferential form of the Boltzmann equation is derived, which includes the effects of the thermal motion of the scattering species and the effects of the rapid increase in the differential scattering cross section at small scattering angles. Solutions of the integrodifferential equation are presented for a system in which energetic tritium atoms are thermalizing and reacting in a mixture of helium, molecular hydrogen, and a scavenger species. Good agreement is found between solutions obtained by this method and those obtained independently by stochastic methods. In all cases treated, significant deviations of the energy distribution of tritium atoms from the Maxwellian distribution are found. The effects of varying the scavenger concentration on the value of the rate constant for an exchange reaction between a tritium atom and a hydrogen molecule are investigated. (auth)

36232 COMPOSITION OF THE THORIUM(IV)-8-HYDROXYQUINOLINE ADDUCT COMPOUND. Corsini, A.; Abraham, J. (McMaster Univ., Hamilton, Ont.). Talanta; 17: 439-42(May 1970).

The orange compound formed between thorium(IV) and 8-hydroxyquinoline by conventional precipitation is nonstoichiometric. The composition is very sensitive to experimental conditions; the average ratio of bound 8-hydroxyquinoline to thorium was found to be 4.9:1. The deficiency of 8-hydroxyquinoline is due either to partial hydrolysis of thorium, or to the presence of co-ordinated water. A simple procedure for the preparation of the pure tetrakis compound is described. (auth) (UK)

36233 BASE-CATALYZED HYDROGEN-DEUTERIUM EXCHANGE OF NITROBENZENE AND RELATED AROMATIC NITRO COMPOUNDS. Guthrie, Robert D.; Wesley, David P. (Univ. of Kentucky, Lexington). J. Amer. Chem. Soc.; 92: 4057-62(1 Jul 1970).

Nitrobenzene and other mononitroaromatics were found to undergo exchange of ortho hydrogen for deuterium in t-butyl alcohol-O-d with potassium t-butoxide at 50°C. The mechanism involves phenyl anions rather than radical anions or alkoxide adducts. The effects of several substituents cannot be explained entirely on the basis of inductive interactions. (auth)

36234 ACETYL PEROXIDE HEAVY ATOM KINETIC ISOTOPE EFFECTS. A REEVALUATION. Goldstein, M. J.; Judson, H. A.; Yoshida, M. (Cornell Univ., Ithaca, N. Y.). J. Amer. Chem. Soc.; 92: 4122-3(1 Jul 1970).

The reproducibility and reliability of a previous report on exact analysis of heavy atom kinetic isotope effects were evaluated. Reactions of acetyl peroxide were studied to investigate the effects of ^{18}O. (M.C.G.)

36235 HYDROGEN ISOTOPIC EXCHANGE IN SUBSTITUTED BENZYLMERCURY CHLORIDES. Bundel, Yu. G.; Rozenberg, V. I.; Reutov, O. A. (Moscow State Univ.). Izv. Akad. Nauk SSSR, Ser. Khim.; No. 4, 918-20(Apr 1970). (In Russian).

The kinetics of acid splitting and isotopic exchange of substituted benzylmercury chlorides under the action of DCl were studied. A similarity in the effects of substitutes on the rate of isotopic exchange and on demetalation was discovered, which is explained by the common mechanism for these two processes. (tr-auth)

36236 METAL ISOTOPE EFFECT ON METAL-LIGAND VIBRATIONS. IV. METAL COMPLEXES OF ACETYLACETONE. Nakamoto, Kazuo; Udovich, Carl; Takemoto, James (Marquette Univ., Milwaukee). J. Amer. Chem. Soc.; 92: 3973-6(1 Jul 1970).

In order to assign the metal-oxygen stretching bands of acetylacetonato complexes, infrared spectra (800 to 100 cm^{-1}) were measured for isotopic pairs of $Fe(acac)_3$ (^{54}Fe and ^{57}Fe), $Cr(acac)_3$ (^{50}Cr and ^{53}Cr), $Pd(acac)_2$ (^{104}Pd and ^{110}Pd), $Cu(acac)_2$ (^{63}Cu and ^{65}Cu), trans-$Ni(acac)_2$(pyridine)$_2$, and $[Ni(acac)_2]_3$ (^{58}Ni and ^{62}Ni). The metal-oxygen stretching bands assigned by normal coordinate analysis show large isotopic shifts relative to other bands. Previously, the Cr-O stretching bands of $Cr(acac)_3$ were assigned from the isotopic shifts due to an $^{16}O-^{18}O$ substitution. Present results show that these assignments are erroneous. (auth)

36237 ANODIZATION OF TANTALUM OVER THE TEMPERATURE RANGE 0° TO 250°C. Dreiner, R. J.; Tripp, T. B. (Sprague Electric Co., North Adams, Mass.). J. Electrochem. Soc.; 117: 858-63(Jul 1970).

Tantalum was anodized at constant current in an aqueous electrolyte over the temperature range 0 to 250°C. The voltage build-up was linear up to a voltage at which crystallization of the oxide occurred. The crystallization voltage decreased with increasing temperature. The change of the voltage build-up rates (dV/dt) with temperature was not compatible with the single barrier law for high field ionic conduction. In spite of the extended temperature range, it was not possible to distinguish between ionic current (i)-field (F) relations of the form $\ln i \propto F^{\frac{1}{2}}$ and $\ln i \propto F + F^2$. Current efficiencies were determined from charge and optical film thickness. The current efficiencies were essentially constant up to a formation temperature of about 170°C and decreased by about 30% between 170° and 250°C. Capacitance and loss angle of equal charge films increased with anodization temperatures higher than about 180°C. Oxygen dissolution in the tantalum substrate was suggested as the likely cause. (auth)

36238 EFFECTS OF SPECIMEN SIZE AND CONFIGURATION IN PLASMA ANODIZATION. Ramasubramanian, N. (Atomic Energy of Canada Limited, Chalk River, Ont.). J. Electrochem. Soc.; 117: 947-9(Jul 1970).

Plasma perturbations resulting from specimen size and presence of a surrounding shield were studied. Anodization characteristics were compared among zirconium and Zircaloy-2 specimens whose areas varied approximately in the ratio 1:2:20. Specimen area and edge effects on oxide formation are discussed. (J.G.B.)

36239 FORMING VOLTAGE IN PLASMA ANODIZATION. (Atomic Energy of Canada Ltd., Chalk River, Ont.). J. Electrochem. Soc.; 117: 949-51(Jul 1970).

Plasma anodization of Ta, Zr, and Zircaloy-2 was studied. Results indicate that errors in anodizing voltage measurements are due to changes in the plasma characteristics during an experiment and work function differences between the anodized and unanodized specimens. These can be eliminated to a large extent by taking the potential of the specimen relative to its floating potential at the end of the experiment. (J.G.B.)

36240 VOLTAMMETRIC BEHAVIOUR OF THE NEPTUNYL SUCCINATE COMPLEX AT THE ROTATING PYROLYTIC GRAPHITE ELECTRODE. Plock, C. E. (Dow Chemical Co., Golden, Colo.). Electrochim. Acta; 15: 899-907(Jun 1970).

The voltammetry of the neptunium(VI) succinate complex was investigated over the pH range 0.7 to 7.0. A reversible, one-electron wave was obtained when the pH was less than 5.8. When the pH was greater than 5.8, an irreversible wave was obtained. In the pH range 0.7 to 4.4, the half-wave potential was a function of the pH, whereas in the pH range 4.4 to 7.0 it was independent of the pH. The metal/ligand ratio was found to be 1:2 by conductometric and amperometric titrations. The limiting current was proportional to the concentration of the neptunium(VI) from 1.30×10^{-4} to 1.63×10^{-3} M with a relative standard deviation of 7.5%. The diffusion coefficient was 0.30×10^{-5} cm^2/s at pH 2.5 and 0.18 cm^2/s at pH 5.4. The stability constant of the neptunyl-succinate ion was 7.4×10^{-3}. (auth) (UK)

36241 THE NATURE OF δ-U_2O_3. Tsvigunov, A. N.; Kovba, L. M. Vestn. Mosk. Univ., Ser. II. Khim.; 11: 59-61 (Jan-Feb 1970). (In Russian).

Analysis of previously published data on δ-U_2O_3 and β-U_2O_3 phases indicates that δ-U_2O_3 is not a new modification of uranium oxide (U_2O_3). (auth)

36242 HYDROLYSIS OF HEXAHALOGENO-TECHNETATE (IV) COMPLEXES. NOTE II. THE BEHAVIOUR IN SOLUTION OF THE PRODUCTS OBTAINED BY MELTING AMMONIUM HEXABROMO-TECHNETATE(IV) WITH KHF_2. Ossicini, Luigia (Univ., Rome. CNR, Rome). Ric. Sci.; 39: 543-8(Jul-Sep 1969). (In Italian).

The preparation of ammonium hexafluorotechnetate(IV) was studied, and extremely low yields were obtained by melting the hexabromo derivative with KHF_2, in an oxygen-free atmosphere. Fluorobromo mixed complexes were predominant in the melt. On dissolution they were readily hydrolyzed and oxidized to pertechnetate, while TcF_6^{2-} is stable, even in alkaline solution. The separation of TcF_6^{2-} was achieved by the chromatographic methods. (auth)

36243 RAMAN SPECTRA AND THE PHONON DISPERSION OF POLYGLYCINE. Small, Enoch W.; Fanconi, Bruno; Peticolas, Warner L. (Univ. of Oregon, Eugene). J. Chem. Phys.; 52: 4369-79(1 May 1970).

The Raman spectra of the two crystalline modifications of polyglycine, I and II, and of N-deuterated polyglycine II were recorded. The results of a normal-coordinate analysis of polyglycine II and N-deuterated polyglycine II are presented along with the phonon dispersion curves of polyglycine II. Assignments are made on a number of bands not observed in the infrared. Some previous band assignments are found to be inconsistent with the Raman data. (auth)

36244 CALCULATION OF GROUND STATE VIBRATIONAL STRUCTURE AND PHONONS OF THE ISOTOPIC BENZENE CRYSTALS. Bernstein, Elliot R. (California Inst. of Tech., Pasadena). J. Chem. Phys.; 52: 4701-16(1 May 1970).

Using the "giant molecule" technique and existing intermolecular potentials, the normal modes, phonon and exciton structure, site shifts, site splitting, and orientational effect for isotopic benzene crystals were calculated. The agreement between the calculations and the experimental observations was good for an H-H, C-H, and C-C potential set independently obtained by Williams from thermodynamic and structural properties of aromatic crystals. The calculation presented serves to unify not only the thermodynamic and spectral properties, but also the diverse spectral properties themselves. This calculation emphasizes that all atom-atom interactions, not just H-H interactions, must be considered for best agreement between calculated and observed spectral data. This conclusion was also reached by Williams with respect to the thermodynamic and structural data. A discussion of the potentials their form and their relation to standard exciton theory integrals is presented. Future improvements in such calculations must be directed, not toward more extensive parametric data fitting of the atom-atom pair potential, but toward more general potential functions that include anharmonicities and multicenter terms. The use of actual site force constants rather than free molecule force constants is also indicated. (auth)

36245 COMPLEX PERMITTIVITY OF D_2O AT 35 GHz OVER THE TEMPERATURE RANGE 4 TO 62.5°C. Grant, E. H.;

Shack, R. (College of Tech., Portsmouth, Eng.). Trans. Faraday Soc.; 65: 1519-22(Jun 1969).

A microwave bridge operating at a frequency of 34.85 GHz was used to measure the complex permittivity of D_2O over the temperature range 4 to 62.5°C. A precision of 0.12 was achieved in both ϵ' and ϵ''. The results were analyzed to provide values of the relaxation time τ_0 and the real component of the permittivity at high frequencies ϵ_∞. The predicted value of the latter parameter was consistent with recent permittivity and absorption measurements carried out in the far infrared. (auth) (UK)

36246 STERIC ISOTOPE EFFECTS. IV. THE DEUTERIUM ISOTOPE EFFECT IN THE RACEMIZATION OF THE (+)-2-(N,N,N-TRIMETHYL)-2'-(N,N-DIMETHYL)-DIAMINOBIPHENYL-6,6'-d_2 CATION. Carter, Robert E.; Dahlgren, Lennart (Univ. of Goteborg. Chalmers Inst. of Tech., Goteborg). Acta Chem. Scand.; 24: 633-43(1970).

The title cation was synthesized and its rate of configurational inversion in aqueous solution extrapolated to zero concentration to determine k_{0D}, the rate in the absence of salt effects, and compared with the rate (k_{0H}) of the corresponding protium compound. The isotopic rate ratio (k_{0D}/k_{0H}) was found to be 1.18 ± 0.04 at 97.73°C, and 1.16 ± 0.05 at 73.41°C. These results are compared with those of Heitner and Leffek on the 2-(N,N,N-tris-trideuteriomethyl)-2'-(N,N-bis-trideuteriomethyl)-diaminobiphenyl cation, for which essentially no isotope effect at all was observed. (auth) (Denmark)

36247 VAPORIZATION THERMODYNAMICS OF YTTRIUM DICARBIDE–CARBON SYSTEM AND DISSOCIATION ENERGY OF YTTRIUM DICARBIDE AND TETRACARBIDE. Kohl, Fred J.; Stearns, Carl A. (Lewis Research Center, Cleveland). J. Chem. Phys.; 52: 6310-15(15 Jun 1970).

The Knudsen effusion method was used in conjunction with a double-focusing mass spectrometer to study the vaporization of the yttrium dicarbide–carbon system. Over the temperature range from 2270 to 2550°K, the measured vapor pressures for yttrium, yttrium dicarbide, and yttrium tetracarbide were found to be $\log_{10}P_Y = (-2.423 \times 10^4/T) + 9.45$, $\log_{10}P_{YC_2} = (-3.286 \times 10^4/T) + 11.95$, $\log_{10}P_{YC_4} = (-4.456 \times 10^4/T) + 14.72$, where the units of pressure are newtons per square meter. Experimentally determined enthalpies were combined with published thermodynamic data to yield the atomization energy of yttrium dicarbide and yttrium tetracarbide: $YC_2(g) = Y(g) + 2C(g) D^\circ_{0,atom} = 1229 \pm 17$ kJ mole^{-1}, $YC_4(g) = Y(g) + 4C(g) D^\circ_{0,atom} = 2461 \pm 18$ kJ mole^{-1}. The heat of formation of solid yttrium dicarbide was calculated as $\Delta H^\circ_{298,f} = -91 \pm 17$ kJ mole^{-1}. (auth)

36248 COMPLEXES OF ANTHRANILIC-N,N-DIACETIC ACID WITH METALS IN THE 4^+ OXIDATION STATE. I. ZIRCONIUM AND HAFNIUM. Dragulescu, C.; Policec, S.; Simonescu, T. Talanta; 17: 557-65(Jul 1970). (In German).

Spectrophotometric studies have shown that zirconium and hafnium form complexes with anthranil-N,N-diacetic acid (ANDA) [indexed as N,N-bis(carboxymethyl)anthranilic acid] in aqueous solution, with the compositions Me:ANDA 1:1 and 1:2. The conditional stepwise formation constants at pH 1 were found to be $k_1 = 20 \pm 5$ and $k_2 = 1.42 \times 10^3$ for zirconium, and $k_1 = 10 \pm 5$ and $k_2 = 1.22 \times 10^3$ for hafnium. (auth) (UK)

36249 CONTRIBUTIONS TO THE STUDY OF METAL-CATALYSED REDUCTION. HYDROGENATION OF METHYL CIS-9-OCTADECENOATE. Nguyen, Dinh-Nguyen; Raal, A. (Univ. of Goteborg). J. Res. Inst. Catal., Hokkaido Univ.; 17: 171-91 (Dec 1969).

Methyl cis-octadecenoate and methyl 9,10-dideutero-cis-9-octadecenoate were reduced with deuterium and with hydrogen over Adams catalyst. The reductions were carried out either in dioxan or acetic acid or acetic acid-d, at room temperature, and under normal pressure. Three deuterations of the nondeuterated ethylenic ester in dioxane showed that the hydrogen redistribution and the deuterium distribution depend on the concentration of the catalyst. A low concentration (5% of the sample weight) of catalyst promotes the light isotope redistribution, while a high concentration (10%) favors the heavy isotope distribution. Hydrogenation of the dideuterated ethylenic ester in dioxane showed the exchange of deuterium (in the carbon chain) for hydrogen and the redistribution of deuterium. Deuteration of this olefin revealed hydrogen redistribution, which was extensive as the deuterium redistribution in the preceding hydrogenation. Reduction of the nondeuterated ethylenic ester carried out with deuterium gas in acetic acid and with hydrogen in acetic acid-d shows the apparent hydrogen–deuterium exchange. This seems to occur partly before the reduction between H^+ or D^+ of solvents and D_2 or H_2 of the reductants, and partly during the reduction between H^+ or D^+ and H_2, H_2 or D, D_2. The H_2-D_2 exchange is also due to the phenomena involving the successive adsorption and desorption of the olefin, the C = C migration, etc., during the reduction. (auth)

36250 EFFECT OF SOLUTES AND TEMPERATURE ON THE STRUCTURE OF DEUTERIUM OXIDE. Bonner, O. D. (Univ. of South Carolina, Columbia). J. Amer. Chem. Soc.; 92: 4197-9 (15 Jul 1970).

The spectrum of liquid D_2O was observed over the range 1200 to 2000 mμ by a differential method in which D_2O at 25° is compared either with a salt solution at the same temperature or D_2O at an elevated temperature. Four combination bands have been observed, which may be identified with the same ones occurring in the vapor phase, and are apparently due to nonbonded D_2O. The band at 1893 mμ was used for quantitative studies, and solvation numbers were calculated for several electrolytes. It appears that the ions are solvated to a greater extent than in H_2O but that the relative order of solvation is similar. The strength of the deuterium bond, as measured from the temperature dependence of the band intensity, is about 11% less than that of the hydrogen bond. Osmotic and activity coefficients are reported for solutions of tetramethylammonium chloride in D_2O, and a comparison of these data and those for alkali halides appearing in the literature seems to confirm the greater solvation of salts in D_2O. (auth)

36251 KINETICS AND MECHANISM OF THE MORPHOLINE–BORANE REDUCTION OF METHYL ALKYL KETONES. White, Sidney S. Jr.; Kelly, Henry C. (Texas Christian Univ., Fort Worth). J. Amer. Chem. Soc.; 92: 4203-9(15 Jul 1970).

Deuterium labeling shows that hydrogen is transferred from boron to the carbonyl carbon atom in the reduction of acetone by morpholine–borane via both acid-independent (second-order) and acid-catalyzed (third-order) paths. The second-order reaction exhibits a negligible solvent isotope effect and a small (10%) normal B–H substrate isotope effect and is presumed to involve the rate-determining attack of amine–borane on the neutral ketone. The acid-catalyzed reaction exhibits a small substrate isotope effect (20%), but shows a pronounced inverse solvent isotope effect [$k_2(D_2O)/k_2(H_2O) = 2.8$] which suggests a rate-determining attack of amine–borane on a protonated carbonyl which is formed in a rapid preequilibrium. From data on ketone basicity, it is calculated that protonation renders the carbonyl compound about 10^{11} times more reactive toward reduction by morpholine–borane. For the acid-independent path, a transition state requiring some specific orientation of reactants is proposed consistent with activation parameters of 11.0 kcal/mol and −40 eu. An analogy to certain cycloaddition reactions is suggested. Correlation of rates with Taft σ^* parameters for C-alkyl substituents in the ketone suggests that boron–oxygen bond formation may be important in this transition state. It is speculated that the protonated carbonyl may serve as a general acid promoting decomposition of the amine–borane in a manner analogous to the proposed mechanism for acid-catalyzed amine–borane hydrolysis. (auth)

36252 MECHANISMS OF ELIMINATION REACTIONS. XIV. STEREOCHEMISTRY AND ISOTOPE EFFECTS IN ELIMINATIONS FROM CYCLOPENTYL- AND 3,3-DIMETHYLCYCLOPENTYLTRIMETHYLAMMONIUM SALTS. Brown, Keith C.; Saunders, William H. Jr. (Univ. of Rochester, N. Y.). J. Amer. Chem. Soc.; 92: 4292-5(15 Jul 1970).

cis-Cyclopentyl-2-d-trimethylammonium (I) and cis-3,3-dimethylcyclopentyl-5-d-trimethylammonium (II) ions were subjected to elimination reactions with various base–solvent combinations. The extent of deuterium loss in the product olefins from I and II, and the proportions of 3,3- and 4,4-dimethylcyclopentene from II were determined. With these data percentages of syn elimination and deuterium isotope effects for syn elimination were calculated. syn elimination was unimportant with hydroxide ion in dilute aqueous solution, but extensive under Hofmann conditions and with potassium t-butoxide in 50 mol % t-butyl alcohol–dimethyl sulfoxide. Isotope effects of syn elimination are all small ($k_H/k_D < 2$), and do not appear to vary significantly from one set of conditions to another. These results are consistent with ideas previously advanced on the stereochemistry of elimination reactions. (auth)

36253 STUDIES IN STEREOCHEMISTRY. XLI. STEREOCHEMICAL COURSE OF THERMAL ISOMERIZATION IN THE INDENE SYSTEM. Almy, John; Cram, Donald J. (Univ. of California, Los Angeles). J. Amer. Chem. Soc.; 92: 4316-20 (15 Jul 1970).

The stereochemical course of thermally induced hydrogen migrations in an indene system in the liquid phase was examined. Optically pure samples of (−)-1-methyl-3-t-butylindene ((−)-I-h), 1-methyl-3-t-butylindene-1-d ((−)-I-d), and (−)-1-methyl-3-t-

butylindene-2-d ((–)-I-d') when heated to 140°C, neat, partially isomerized to 3-methyl-1-t-butylindene (II-h(d)). The resulting mixtures (far from being equilibrated) were separated, and the samples of I and II were analyzed for optical purity. The product II-h, isolated from isomerization of (–)-I-h was 99% racemic, and the 1% remainder possessed the configuration predicted by an overall suprafacial hydrogen shift ((–)-I → (+)-II). The near racemic character of II strongly supports the intervention of the optically inactive isoindene intermediate of type A in the major reaction. The small residual activity is accommodated by the less-favored occurrence of optically active intermediates of types B and C in the production of a small fraction of II. Starting material deuterated in the 1 position ((–)-I-d) isomerized a factor of 3 slower than (–)-I-h, and after 13.5% isomerization gave II, 48% optically pure. The optically active component possessed the configuration predicted by an antarafacial hydrogen shift ((–)-I → (–)-II). The result pointed to a deuterated, optically active isoindene intermediate (type A, monodeuterated) whose hydrogen in the 2 position completed the migration (started by deuterium) faster than did the deuterium due to a kinetic isotope effect of about 2.9. Optically pure (–)-I-d' (deuterium in the 2 position) was prepared and 22% isomerized to II, which was 42% optically pure, and whose optically active component possessed a configuration in which the benzyl hydrogen or deuterium possessed a configuration suprafacially related to that of starting material. This result pointed to a kinetic isotope effect of 2.7 for the formation of II from deuterated intermediate A. (auth)

36254 ELECTROPHILIC SUBSTITUTION AT SATURATED CARBON. XLIV. STEREOCHEMICAL AND ISOTOPIC DROWNING PHENOMENA. Almy, John; Garwood, Donald C.; Cram, Donald J. (Univ. of California, Los Angeles). J. Amer. Chem. Soc.; 92: 4321-30(15 Jul 1970).

Optically pure (–)-3-t-butyl-1-methylindene-1-h ((–)-I-h), or its counterpart deuterated in the 1 position ((–)-I-d), was subjected to simultaneous base-catalyzed racemization, isotopic exchange, and isomerization to 1-t-butyl-3-methylindene (II) in various media. In all of the runs made for product analysis, after 5 to 45% isomerization, the reaction was interrupted, and I and II were separated by glpc and examined for optical purity and deuterium. In CH_3OD-CH_3OK (0.10 M) at 25°, (–)-I-h gave completely racemic II which was only 87% deuterated, and the reaction, although nonstereospecific, was 13% intramolecular. In CH_3OH-CH_3OK (0.10 M) at 24°C, (–)-I-d gave completely racemic II which possessed <0.5% deuterium and the reaction was <0.5% intramolecular. Thus, drowning of CH_3OD generated in a pool of CH_3OH appears to occur at least an order of magnitude faster than drowning of CH_3OH generated in a pool of CH_3OD. At 25°C with potassium methoxide as catalyst, the rate of loss of optical activity (rate constant, k_a) from a reacting solution of (–)-I-h in CH_3OD-CH_3OK at 25°C was strictly first order over four half-lives. Over the first 20% of reaction the rate constant for isotopic exchange of I (k_e) was first order. Over the first 13% of isomerization the rate constant (k_i) was first order. Within error $k_e/k_a \sim 1$. Analysis of the kinetic data established that the rate constants for isotopic exchange of (–)-I-h in methanol-O-d with retention and inversion were strictly equal to one another. Addition of 18-crown 6-ether (III, 0.20 M) to the CH_3OD-CH_3OK (0.10 M) medium had only minor effects on the three reactions of (–)-I-h. In 25% phenol–75% benzene by volume potassium phenoxide (0.058 M) at 100°C, $k_e/k_a = 8$ for (–)-I-h in the absence and $k_e/k_a = 2$ in the presence of 18-crown 6-ether (0.1 M). The isomerization rate was depressed by almost a power of ten by the crown ether, III. In the absence of III, the 11% of (+)-II produced was 10% racemic and 87% isotopically exchanged, whereas in the presence of III, the 6% of (+)-II produced was 75% racemic and 77% isotopically exchanged. At 37°C in tetrahydrofuran (0.19 M in $n-C_3H_7ND_2$), (–)-I-h after 46% isomerization gave $k_e/k_a > 30$ for I, and 0% racemization and 17% isotopic exchange for II. Under the same conditions in the presence of 1.5 M crown ether (III) after 38% isomerization, k_e/k_a for (–)-I-h fell to 0.6 without much effect on the rate of isomerization. The II produced was 21% racemized and 10% isotopically exchanged. The mechanisms of these proton transfer reactions are discussed in terms of contact and separated ion pairs and dissociated ions. The stereochemical and isotopic drowning phenomena are interpreted in terms of both hydrogen-bonded carbanions and solvent cages structured by hydrogen bonds. (auth)

36255 CONCURRENT GENERAL-ACID AND GENERAL-BASE CATALYSIS OF ESTERIFICATION. Milstien, Sheldon; Cohen, Louis A. (National Institutes of Health, Bethesda, Md.). J. Amer. Chem. Soc.; 92: 4377-82(15 Jul 1970).

The rates of lactonization of a series of β,β-dimethyl(2-hydroxy-5-X)hydrocinnamic acids were determined as functions of X (eight variations), pH, and buffer components. The rate of hydronium ion catalyzed lactonization increases with the pK of the phenolic nucleophile ($\rho = -1.68$) and shows a solvent–deuterium isotope effect of ca. 0.9. In weakly acidic media, lactonization was found to proceed at measurable rates, the reaction being catalyzed concurrently and independently by the acidic and basic buffer species ($\rho_{RCOOH} = -1.50$; $\rho_{RCOO^-} = -0.80$). For X = OCH_3, $k'_{obsd} = 10^{-3}(0.083[H_3O] + 4360[H_3O^+] + 7.20[HCOOH] + 23.2[HCOO^-] + 3.50[CH_3COOH] + 27.5[CH_3COO^-])$. No evidence was found for concerted catalysis by both buffer species. The buffer components show kinetic-solvent isotope effects of ca. 2. Activation entropies of –20 eu for hydronium ion and –28 eu for buffer acid catalysis were observed. Although the kinetic results, isotope effects, and activation entropies fail to distinguish between rate-determining formation or breakdown of a tetrahedral intermediate, the variations in ρ are considered to favor the latter as the rate-limiting step. (auth)

36256 CARBON ISOTOPE EFFECTS ON THE ENZYMATIC DECARBOXYLATION OF GLUTAMIC ACID. O'Leary, Marion H.; Richards, David T.; Hendrickson, David W. (Univ. of Wisconsin, Madison). J. Amer. Chem. Soc.; 92: 4435-40(15 Jul 1970).

Steady-state kinetic parameters and carbon isotope effects were measured for the enzymatic decarboxylation of glutamic acid from pH 3.6 to 5.5. Over this range the maximum velocity changes by less than 50%, reaching a maximum at pH 4.4. The carbon isotope effect varies from a minimum of $k^{12}/k^{13} = 1.014$ at pH 4.0 to a maximum of 1.022 at pH 5.5. These data indicate that the energy barriers for decarboxylation and for formation of the enzyme–substrate complex are very similar. Decomposition of the enzyme–substrate complex to reform enzyme and substrate occurs with general base or general acid–specific base catalysis. (auth)

36257 RELATIVE RATES OF ADDITION OF CYCLOPROPYL RADICALS TO OLEFINS. I. Stefani, Andrew P.; Chaung, Lanyuh Yang; Todd, H. E. (Univ. of Missippi, University). J. Amer. Chem. Soc.; 92: 4168-73(15 Jul 1970).

The relative rates of addition of cyclopropyl radicals to a series of olefins were measured in order to obtain information in regard to the electronic and steric demands of these radicals. A monotonic decrease in reactivity is observed as the number of alkyl groups about the double bond increases. The relationship of the rate data with the ionization potentials of the olefins and the effect of electronegative substituents upon the rates suggest that cyclopropyl radicals are decidedly nucleophilic. A compensation effect is noted in the trends of the energies and entropies of activation. The analysis of the variations of the activation parameters with substrate structure implies a proportionality between electronic and steric effects in the transition state. The magnitude of the observed secondary deuterium effect and the correlation of the data with bond localization energies are discussed in terms of the mechanism of the reaction and the structure of the transition state. (auth)

36258 URANIUM CHALCOGENIDES. III. HEAT CAPACITIES AND THERMODYNAMIC PROPERTIES OF $US_{1.9}$ AND USe_2 FROM 5 TO 350°K. Westrum, Edgar F. Jr. (Univ. of Michigan, Ann Arbor); Groenvold, Fredrik. J. Inorg. Nucl. Chem.; 32: 2169-77(Jul 1970).

Heat capacities were measured and derived thermodynamic properties calculated for the structurally related $US_{1.9}$ and USe_2 phases from 5 to 350°K. Values of the heat capacity (C_p), entropy ($S^0-S_0^0$) and Gibbs energy function $[-(G^0-H_0^0)/T]$ at 298.15°K in cal $mole^{-1}$ $°K^{-1}$ are 17.68, 25.91 and 13.82 for $US_{1.9}$ and 18.92, 31.98 and 17.86 for USe_2, respectively. Schottky-type anomalies are present in $US_{1.9}$; a λ-type thermal anomaly with $\Delta St = 0.19$ cal $mole^{-1}$ $°K^{-1}$ occurs at 13.1 °K in USe_2. (auth) (UK)

36259 CHRONOPOTENTIOMETRIC STUDY OF THE REACTION Pu(IV) + e → Pu(III) IN MOLTEN LiCl–KCl EUTECTIC. Martinot, L.; Duyckaerts, G. (Lab. of Nuclear Chemistry, Liege). Inorg. Nucl. Chem. Lett.; 6: 587-93(Jun 1970).

The diffusion of the Pu(IV) ion dissolved in LiCl–KCl eutectic was studied by chronopotentiometry in the temperature range 400 to 650°C. The diffusion coefficient at various temperatures was measured, and the variation of the activation energy for diffusion, on the base of the "hole" theory for molten salts, is discussed. (auth) (UK)

36260 URANIUM(IV) CHLOROCYANIDE COMPLEX. Bagnall, K. W.; Baptist, J. L. (Univ. of Manchester, Eng.). J. Inorg. Nucl. Chem.; 32: 2283-5(Jul 1970).

Uranium tetrachloride does not react with alkali metal cyanides in liquid hydrogen cyanide, from which only a uranium tetrachloride solvate can be isolated. Replacement of chloride by cyanide ion occurs in anhydrous liquid ammonia, and the complex $UCl_3CN \cdot 4NH_3$ was obtained. (auth) (UK)

36261 ELECTROCHEMICAL PROPERTIES OF NpO_5(VII) IN MOLTEN KOH–NaOH EUTECTIC. Martinot, L.; Duyckaerts, G. (Lab. of Nuclear Chemistry, Liege). Inorg. Nucl. Chem. Lett.; 6: 541-8(Jun 1970).

The object of the study described was to measure the diffusion coefficient of NpO_5(VII) in the molten eutectic and to clarify its electrochemical reduction mechanism. It was found that at 240°C reduction proceeds in one step: $NpO_5^{3-} + 3e^- \rightarrow NpO_2 + 3O^{2-}$, whereas at 290°C it proceeds in two steps: $NpO_5^{3-} + 2e^- \rightarrow NpO_4^{3-} + O^{2-}$ and $NpO_4^{3-} + e^- \rightarrow NpO_3$. The Np(VII) was obtained by dissolving NpO_2 in the bath, which in some cases contained Na_2O_2, and bubbling O_2 through for a few minutes. Chronopotentiometry was used in the reduction studies. (UK)

36262 IDENTIFICATION OF THE PLUTONYL(VI) COMPOUND PRECIPITATED FROM AMMONIUM HYDROXIDE AND PYRIDINE SOLUTIONS. Cleveland, J. M. (Dow Chemical Co., Golden, Colo.). Inorg. Nucl. Chem. Lett.; 6: 535-40(Jun 1970).

A small but significant gap in plutonium chemistry concerns the identity of the plutonyl(VI) compound precipitated from NH_4OH solution. The problem has received very little investigation, and the few results that have been published are questionable. The preparation of ammonium plutonate has been reported, but the compound was not characterized and its identity was merely inferred from the method of preparation. Russian workers have described the preparation of ammonium diplutonate, $(NH_4)_2Pu_2O_7$, but the characterization was based on analogy with the uranyl(VI) system, without any analytical data. Since the existence of ammonium diuranate is doubtful, the reported preparation of ammonium diplutonate is open to question. In the absence of reliable information, the investigation described was undertaken to identify the plutonyl(VI) species precipitated from weak base solutions. (auth) (UK)

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Refer also to abstracts 36204, 37003, 37177, 37536, 37540–37542, and 38155.

36263 (AE–397) NUCLEAR CHEMISTRY PROGRESS REPORT, 1969. Carleson, Goeran (Aktiebolaget Atomenergi, Studsvik (Sweden)). May 1970. 39p. Dep. CFSTI (U. S. Sales Only).

Phase diagrams of some lithium and calcium halides in light and heavy water were constructed in the temperature range –85 to 60°C. New hydrates were observed and their range of existence determined. Radicals formed after irradiations of highly purified water and water solutions of simple aromatics with fast electrons and gammas as well as their subsequent decay and kinetics were studied by pulse radiolysis techniques. Pulse radiolysis of heavy ice between –5 and –190°C showed that the absorption spectrum of the solvated electron is shifted to higher energies with decreasing temperature. Compared to H_2O ice the maximum is displaced to an energy that is 0.04 eV higher. After an initial decrease the yield increases below –100°C. Single crystals of vinyl monomers were prepared by a special low-temperature technique. After irradiations with gamma rays at 77°K; radical pairs and other paramagnetic species were identified by ESR spectroscopy. The crystal structures of methyl acrylate and methyl methacrylate were determined by x-ray diffraction. Inorganic ion exchangers of zirconium phosphate and silica gel type were shown to be completely stable to degradation up to a dose of 3×10^5 Mrads. Sturdy solid dosimeters based on the measurement of luminiscence or color difference in higher benzene homologs were developed and shown to have a precision better than ±15% in the dose range 1 to 5×10^3 Mrads. Earlier observed anomalies for radiation-cured pine and birch wood polymer combinations, such as inhomogeneous polymer distribution in lengthy wood samples and large variations in polymer conversions for almost identical test materials, were further studied and the experimental results statistically treated. Methods for the determination of low contents of oxygen and carbon in metals such as aluminum and steel by means of charged particle activation analysis are being developed. The sensitivities of applicable nuclear reactions were evaluated at various proton energies. Low-temperature techniques were adapted to neutron activation analysis in aqueous and biological materials in order to increase the sensitivity of the determinations. (auth)

36264 (ACEL–3567) PULSE RADIOLYSIS: CONVERSION TABLES % ABSORPTION TO OPTICAL DENSITY, LOG_{10} (OPTICAL DENSITY) AND RECIPROCAL OPTICAL DENSITY. Richards, P. J. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Mar 1970. 60p. Dep. CFSTI (U. S. Sales Only). AECL $1.50.

36265 (CALT–767–P–4–63) STUDIES IN CHEMICAL DYNAMICS AND RADIATION CHEMISTRY. Technical Progress Report, July 1, 1969–June 30, 1970. Kuppermann, Aron (California Inst. of Tech., Pasadena). Contract AT(04-3)-767. 28p. Dep. CFSTI.

Progress is reported on low-energy electron scattering, photoelectron spectrometry, elementary reactions by photolysis at various wavelengths, collisions in crossed molecular beams, theory of chemical reactions, and diffusion kinetics in radiation chemistry. (M.C.G.)

36266 (CEA–R–3962) STUDY OF THE STABILITY OF SOME NEW ORGANIC MOLECULES AFTER γ IRRADIATION. Megemont, Charles; Felix, Claude; Sy, Michel (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Apr 1970. 21p. (In French). Dep. CFSTI (U. S. Sales Only).

The stability of twelve organic molecules irradiated in increasing γ fluxes was studied in the laboratory of radiotoxicology. The properties of uracil and thiouracil compounds, the experimental conditions, and the infrared spectra of the described compounds are given. These compounds are not damaged by irradiation in fluxes of 100,000 R/h in crystallized phase or in absolute ethanol solution. (France)

36267 (COO–38–738) PROCEEDINGS OF THE SYMPOSIUM ON VERY EARLY EFFECTS. International Meeting on Primary Radiation Effects in Chemistry and Biology, March 9–14, 1970, Buenos Aires. Helman, W. Phillip; Mozumder, Asokendu; Ross, Alberta (eds.) (Comision Nacional de Energia Atomica, Buenos Aires (Argentina). Notre Dame Univ., Ind. Radiation Lab.). May 1970. Contract AT(11-1)-38. 256p. (CONF-700319). Dep. CFSTI.

A record of the conversation concerning Very Early Processes in Radiation Chemistry and Radiation Biology to examine attainments, position and ignorance, and to consider the future and what answers and questions will emerge is presented. The topics discussed include: introduction of problems to be considered; the nature and behavior of excess electrons; electric field dependence of mobilities; thermalization and localization of electrons; thermalization models; dielectric relaxation; superexcited states and ionization; events in the solid state, earliest events in water; earliest effects observed in water; biological implications of early time events; nomenclature of electrons; and the nature of solvated electrons. (P.C.H.)

36268 (LIB–Trans–264) THE APPLICABILITY OF THE ALLEN'S MODEL TO THE RADIOLYSIS OF AQUEOUS SOLUTIONS. Firsov, V. G.; Ershler, B. H. Translated by V. Gavriloff (Australian Atomic Energy Commission Research Establishment, Lucas Heights), from Dokl. Akad. Nauk SSSR; 138: No. 4, 884-5 (1961). 7p. Dep. CFSTI (U. S. Sales Only).

An abstract of this paper, prepared from the original language, appeared as NSA 15: 26082.

36269 (ORNL–4540) TRANSURANIUM PROCESSING PLANT SEMIANNUAL REPORT OF PRODUCTION, STATUS, AND PLANS FOR PERIOD ENDING DECEMBER 31, 1969. Burch, W. D.; Bigelow, J. E.; King, L. J. (Oak Ridge National Lab., Tenn.). Jun 1970. Contract W-7405-eng-26. 34p. Dep. CFSTI.

The total amounts of transuranium elements recovered during the period July 1, 1969, to December 31, 1969, are: 3 g of ^{242}Pu, 0.8 g of ^{243}Am, 16.8 g of ^{244}Cm, 12.8 mg of ^{252}Cf, 2 mg of ^{249}Bk, 82 μg of ^{253}Es, and 1.5×10^8 atoms of ^{257}Fm. The processing schedule was changed significantly. Plans are now to process 163 Savannah River Plant (SRP) reactor slugs during fiscal year 1971 (i.e., July 1970 through June 1971). These slugs, which contain americium and curium, are being irradiated in the "Californium-I" phase of a program at SRP to produce ^{252}Cf for use in the USAEC program to evaluate the commercial market for californium. The original plans for processing irradiated HFIR targets were modified somewhat in order to accommodate the slugs. The following total amounts of transuranium elements are expected to be produced during the next 18 months: 72.5 mg of ^{249}Bk, 492 mg of ^{252}Cf (122 mg from HFIR targets for research, and 370 mg from SRP slugs for the program for evaluating the commercial applications of californium), 1.3 mg of ^{253}Es, and 1.8×10^9 atoms of ^{257}Fm. The sequence of process steps currently being used at TRU is reviewed and the status of each step is summarized. Four neutron sources containing about 1 mg each of ^{252}Cf, and one neutron source containing about 2 mg of ^{252}Cf, were fabricated during this report period. A gamma source, containing 1 mg of ^{244}Cm and 200 mg of ^{13}C, was also fabricated. This source, which emits a sharply-defined 6130-keV gamma ray, is used for calibrating high-energy gamma detectors. (auth)

36270 (UJV–2414–Ch) SOME CHEMICAL AND ANALYTICAL PROBLEMS CONNECTED WITH ^{99m}Tc GENERATORS. Vesely, P.;

Cifka, J. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). May 1970. 20p. (CONF-700517-4). Dep. CFSTI (U. S. Sales Only).

From Preparation and Control of Radiopharmaceuticals Conference, Vienna, Austria.

The sensitivities of various methods for the determination of radionuclidic impurities were compared. The results of paper chromatographic analyses of commercial generators are reviewed. The differences in biological behavior are demonstrated. The causes of low elution efficiency were studied; small efficiency is probably due to the radiation reduction of pertechnetate to the tetravalent state. (auth)

36271 LAWS GOVERNING THE SUPPLEMENTARY CONDUCTIVITY INDUCED BY X RADIATION IN LIQUID ORGANIC PHOTO-CONDUCTORS. III. THE JOINT EFFECT OF LIGHT AND X RADIATION. Koval, V. M.; Kopylov, Yu. A.; Trofimova, T. N.; Svergunenko, L. A. (Dnepropetrovsk Agricultural Inst., USSR. Dnepropetrovsk Medical Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 6, 85-9(1969). (In Russian).

Following up earlier studies on the laws of photoconductivity induced by x radiation, an attempt was made to determine whether illumination of liquid organic photoconductors stimulates the recombination of current carriers induced by x radiation; this effect was expected to be manifested by a reduction of the "roentgenoconductance." The experiments were carried with benzene iodide dissolved in diethyl ether; the solution was exposed to a mercury quartz lamp and to an x-ray source. The data indicated that different mechanisms are involved in the formation of current carriers by light and x rays. Exposure to light induces an intermediate long-lived, predissociated stage while x radiation creates current carriers directly. It destroys the predissociated stage by reducing its lifetime. Illumination facilitates the recombination of the current carriers, regardless of the mechanism involved in their formation. (TTT)

36272 THERMAL ANNEALING OF IRRADIATED LITHIUM HYDRIDE. I. MEASUREMENT OF STORED ENERGY. Newkirk, H. W.; Leider, H. R. (Univ. of California, Livermore). J. Phys. Chem. Solids; 31: 1069-73(May 1970).

The release of stored energy from irradiated LiH during thermal annealing was measured with a differential thermal analysis technique. For all samples irradiated with ^{60}Co γ rays to doses between 1×10^9 and 5×10^{10} Rad at temperatures ranging from 40 to 270°C, the amount of stored energy was directly proportional to the amount of motionally narrowed hydrogen seen in the material by pulsed nuclear magnetic resonance. The energy release is from the recombination reaction of free lithium and hydrogen that have been produced by irradiation; the energy for the reaction $Li_{(c)} + \frac{1}{2}H_{2(c)} \rightarrow LiH_{(c)}$ was ~20 kcal/mole. This is comparable to the standard heat of formation of LiH, $\Delta H_f^\circ = -21.7$ kcal/mole. (auth) (UK)

36273 ELECTRON RESONANCE STUDY OF ATOMIC TRITIUM FORMED IN NEUTRON-IRRADIATED LITHIUM FLUORIDE CRYSTALS. Causa, Maria T.; Raoux, Denis; Taupin, Christiane (Laboratoire de Physique des Solides, Orsay, France). J. Phys. Chem. Solids; 31: 1011-18(May 1970). (In French).

An EPR investigation of neutron irradiated LiF single crystals shows that atomic tritium may be found in several sites of the lattice. One of them was identified: it is the $\frac{1}{4}$, $\frac{1}{4}$, $\frac{1}{4}$ interstitial site. Quantitative interpretation of this EPR spectrum needs the relaxation of the lattice. The nearest neighbor ions have to be pushed away from the interstitial site by 20% of their distance. (auth) (UK)

36274 RADIATION-INDUCED ISOMERIZATION OF THE 1,2-DIPHENYLPROPENES IN BENZENE AND CYCLOHEXANE. Hentz, Robert R.; Altmiller, H. G. (Univ. of Notre Dame, Ind.). J. Phys. Chem.; 74: 2646-51(25 Jun 1970). (COO-38-694).

Photoexcited and photosensitized isomerizations of the 1,2-diphenylpropenes and their radioinduced isomerizations in benzene and cyclohexane were studied. For the concentration range studied, 2 to 50 mM, the photochemical results can be summarized as follows (multiplicity of the solute state excited is denoted by a superscript): $^1\phi_{t\rightarrow c} = {}^3\phi_{t\rightarrow c} = 0.545$ and $^1\phi_{c\rightarrow t} = {}^3\phi_{c\rightarrow t} = 0.455$, corresponding to $\phi_{t\rightarrow c}/\phi_{c\rightarrow t} = 1.20$. The 1,2-diphenylpropenes were found to be efficient quenchers of benzene fluorescence. For the lowest excited singlet of benzene, the products of lifetime and specific rate of excitation transfer were 1200 M^{-1} and 700 M^{-1} for the trans and cis isomers, respectively, as quenchers. Radioinduced isomerizations of the 1,2-diphenylpropenes provide a measure of the yield of solute excited states, G*, up to at least 0.1 M in cyclohexane and 1 M in benzene. Isomerization yields in cyclohexane are somewhat larger than those obtained earlier with trans-stilbene but can be accommodated by the same model. For solute concentrations greater than ~0.1 M in benzene, mechanistic complexity precludes a correlation between G* and yields of solvent precursors. However, with a value from other work of $^1G_s = 1.5$ for the lowest excited singlet of benzene, results for solute concentrations less than 0.1 M give $^3G_s = 4.1$ for the yield of benzene triplets which do not have the lowest excited singlet as a precursor. Much of the published work on radioinduced isomerizations in benzene can be interpreted in terms of $^1G_s = 1.5$, $^3G_s = 4.1$, and $\chi = 0.60$ for the intersystem crossing probability from the lowest excited singlet of benzene. Reconciliation with pulse-radiolysis results remains a major problem. (auth)

36275 SYNTHESIS OF AMINO ACIDS BY PROTON IRRADIATION OF GAS MIXTURES CONTAINING AMMONIA OR FREE NITROGEN. Vinogradov, A. P.; Vdovykin, G. P. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Geochem. Int. (Engl. Transl.); 6: 849-52(Jun 1970).

Translated from Geokhimiya; No. 9, 1035-8(1969).

Six mixtures of simple carbon and nitrogen compounds, nitrogen, and sulfur (CH_4, CO_2, CO, C, NH_3, NH_4Cl, S_2) were irradiated in the presence of water. Irradiations conducted with 600-MeV protons (integrated flux, 5.4×10^{14} protons/cm^2) led to the synthesis of glycine, alanine, glutamic and aspartic acids, lysine, histidine, valine, and leucine. Amino acids were synthesized when either ammonia or free nitrogen was used, but the use of ammonia led to higher yields. (auth)

36276 ISOTROPIC EPR SPECTRA FROM FREE RADICALS TRAPPED IN AN ADAMANTANE MATRIX. Wood, David E.; Lloyd, Roger V. (Carnegie-Mellon Univ., Pittsburgh). J. Chem. Phys.; 52: 3840-1(1 Apr 1970).

Small amounts of impurities deliberately added to a solid adamantane matrix undergo selective radiation damage to give trapped free radicals, which exhibit solution-like, isotropic, EPR spectra. Typical radicals in adamantane have a half-life of about 10 hr at room temperature and isotropic EPR spectra were obtained from −120 to 80°C. Studies on free radicals obtained by x irradiation of aliphatic amines in the adamantane matrix are reported. The radicals are formed by removal of a hydrogen atom alpha to the amine group. (M.C.G.)

36277 ELECTRON SPIN RESONANCE AND ELECTRONIC STRUCTURE OF THE FLUOROMALONYL RADICAL, $CF(CO_2^-)_2$. Herring, F. G.; Lin, W. C.; Mustafa, M. R. (Univ. of British Columbia, Vancouver). J. Magn. Resonance; 2: 9-18(Jan 1970).

The x-irradiation of single crystals of dipotassium difluoromalonate monohydrate was shown by ESR to lead to the stable radical $\dot{C}F(CO_2^-)_2$ being formed. The principal values of the fluorine hyperfine coupling are |208|, |27|, and |17| gauss. A study of previously reported fluorine hyperfine couplings together with the present one led to a reasonable understanding of the variation of the fluorine anisotropy from radical to radical. An INDO-LCAO-SCF calculation was carried out on this radical. (auth) (UK)

36278 PHOTOLYSIS AND RADIOLYSIS OF 3-METHYL-2-BUTANONE. Scala, Alfred A. (Worcester Polytechnic Inst., Mass.). J. Phys. Chem.; 74: 2639-45(25 Jun 1970).

In the photolysis of 3-methyl-2-butanone at 253.7 nm the major modes of fragmentation of the excited ketone molecules are $CH_3COCH(CH_3)_2^\ddagger \rightarrow CH_3CO + i\text{-}C_3H_7$ and $CH_3COCH(CH_3)_2^\ddagger \rightarrow CH_3 + COCH(CH_3)_2$. On the basis of experiments carried out with 3-methyl-2-butanone-α-d_4 it can be concluded that the loss of a methyl from the isopropyl group of the ketone occurs with the quantum yield of 0.020 ± 0.005: $CD_3COCD(CH_3)_2^\ddagger \rightarrow CD_3COCDCH_3 + CH_3$. No evidence was found for the occurrence of the Type III molecular elimination of propylene. In the vacuum ultraviolet photolysis in addition to the processes observed at 253.7 nm the loss of an H atom is observed. The following overall net reaction is the major process occurring: $CH_3COCH(CH_3)_2^\ddagger \rightarrow CH_3 + CO + C_3H_8 + H$. The molecular elimination of CH_3D from 3-methyl-2-butanone-α-d_4 occurs with a quantum yield of 0.020 ± 0.005 at both 147.0 and 123.6 nm: $CD_3COCD(CH_3)_2^\ddagger \rightarrow CD_3COCCH_3 + CH_3D$. In the radiolysis the major ion molecular reaction that occurs is the transfer of a proton from fragment ions to the ketone. (auth)

36279 YIELD OF FREE-IONS IN THE RADIOLYSIS OF FORMAMIDE, A LIQUID OF VERY HIGH DIELECTRIC CONSTANT. Head, D. A.; Walker, D. C. (Univ. of British Columbia, Vancouver). Can. J. Chem. 48: 1657-63(1 Jun 1970).

Solutions of N_2O in liquid formamide (dielectric constant 109) gave a yield of N_2 during γ radiolysis of $G(N_2) = 3.3 \pm 0.3$. Competition between N_2O and other scavengers, including water, ethanol, acids, $AgNO_3$, and CdI_2 strongly resembled the pattern of reactivity characteristic of solvated electrons found in other polar

liquids. Furthermore, the yield obtained (3.3) was consistent with the high dielectric constant and predicted for the free-ion yield by Freeman's model assuming a total ionization of 4.7. However, the absence of an absorption band in nanosecond pulse radiolysis experiments suggests that solvated electrons were not present 10^{-9} sec after the passage of the ionizing radiation. It is quite possible that in this system solvent anions (or other reactive reducing ions) were formed in yield equal to the "free-ion" yield. This presupposes that formamide anions readily reduce N_2O and Ag^+, are inactivated by H^+ and do not react with water and alcohols. The high dielectric constant apparently leads to large yields of comparatively long-lived (>10^{-7} sec) reducing ions (free-ion yield of 3.3) accompanied by rather small yields of H atoms and simple molecular decomposition products. In these respects the radiolysis decomposition of formamide resembles that of water. (auth)

36280 KINETIC STUDY OF THE ADDITION OF TRIFLUOROMETHYL RADICALS TO ETHYLENE IN HYDROCARBON SOLUTION. Weir, Richard A.; Infelta, Pierre P.; Schuler, Robert H. (Carnegie-Mellon Univ., Pittsburgh). J. Phys. Chem.; 74: 2596-2601(25 Jun 1970).

The addition of CF_3 radicals to ethylene in competition with their reaction with iodine was studied in cyclohexane and heptane solutions. Measurements in both solvents at room temperature give the relative rate of the former to the latter reaction as ~0.0035. In heptane the temperature coefficient of the rate constant ratio over the range −80 to 25°C corresponds to an activation energy difference of 1290 cal/mole. For the addition reaction itself the activation energy is estimated as 3500 cal/mole, the steric factor as 0.03, and the absolute reaction rate constant at room temperature as 3×10^6 M^{-1} sec^{-1}. This latter value is essentially identical with that found in a recent study in the vapor phase. (auth)

36281 PREPARATION OF ^{28}Mg IN A NUCLEAR REACTOR. Mirza, M. Y. (Pakistan Inst. of Nuclear Science and Tech., Islamabad); Nilore, P. O. Radiochim. Acta; 13: 73-5(1970).

^{28}Mg was produced by the $^{26}Mg(t,p)^{28}Mg$ reaction using tritons from the $^6Li(n,t)^4He$ reaction. A simple method was devised for separation of ^{28}Mg activities from irradiated Mg−Li alloy, using 1-phenyl-3-methyl-4-capryl-pyrazolone-5 in methyl isobutyl ketone as an extracting agent. 80% ^{28}Mg with a decontamination factor of 1×10^5 from Fe, Mn, Zn, and Cd can be removed in less than 30 min. (auth)

36282 pH MEASUREMENT IN THE DIFFUSION LAYER IN ION EXCHANGE MEMBRANES. Roemer, J.; Schwabe, K. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger. Technische Univ., Dresden, Ger. Institut fuer Elektrochemie, Dresden, Ger.). Electrochim. Acta; 15: 885-97(Jun 1970). (In German).

Measurements of pH at anion-exchange membranes (AEM) in an electrodialysis cell are reported. The measurements were carried out by a special bismuth electrode. The cell was +Pt/HNO_3/AEM/NaOH/Pt−. If electrolytic current flows, strongly alkaline layers are formed at the anodic side of the membrane. The pH of these layers was investigated as to dependence on current density, acid concentration, stirring, and concentration of fixed ions. One can calculate from the measurements the thickness of the diffusion layer in agreement with known values. Optimal conditions of electrodialysis for the preparation of β sources are suggested. (auth) (UK)

36283 PRODUCTION OF CARRIER-FREE ^{54}Mn. Michailov, M. Sorantin, H. (Reaktorzentrum, Seibersdorf, Austria). Atompraxis 16: 183-5(May-Jul 1970). (In German).

Carrier-free ^{54}Mn can be prepared easily by irradiation of iron wire with fast neutrons, dissolution in HCl, extraction of the ^{59}Fe with oleic acid, and removal of the simultaneously produced ^{51}Cr by solvent extraction. (auth)

36284 CHEMICAL EFFECTS OF NEUTRON-INDUCED NUCLEAR REACTIONS IN HALATES AND RELATED COMPOUNDS. III. THE (n,γ) AND (n,2n) REACTIONS IN IODATES. Ambe, Fumitoshi; Saito, Nobufusa (Inst. of Physical and Chemical Research, Saitama, Japan). Radiochim. Acta; 13: 105-11(1970).

The oxidation state of the radioiodine atoms produced by the (n,γ) and (n,2n) reactions was studied in various iodates and related compounds, particular attention being paid to the effect of cations, the water of crystallization, and the type of nuclear reaction on the behavior of the recoil iodine atoms. Heavy alkali iodates were found to give retention values higher than those of sodium and potassium iodates. In hydrates, a large cation effect was found between sodium iodate and the iodates of transition metals. Hydrates gave lower retention values than the anhydrous salts with the same cation in every pair studied. The origin of these effects is discussed in terms of the physicochemical properties of the salts. Rapidly frozen solutions of sodium and potassium iodates were found to show retention values very close to that of sodium iodate monohydrate. In acid compounds, no simple relation could be established between the retention and the chemical composition. The retention of ^{126}I after the (n,2n) reaction was lower than that of ^{128}I after the (n,γ) reaction for every compound in which the comparison was made. Deuteration of the water of crystallization caused no significant change in retention of sodium iodate monohydrate. (auth)

36285 EFFECTS OF AGEING AND ANNEALING TEMPERATURE ON THE TENSILE PROPERTIES OF ROLLED AND IRRADIATED POLYETHYLENE. Tsunekawa, Yoshinori (Kobe Univ., Japan). Kobe Shosen Daigaku Kiyo. Dai-2-Rui. Kokai, Kikan, Rigaku-hen; No. 17, 129-32(Mar 1970). (In Japanese).

Low-temperature heating of high-density polyethylene followed by irradiation sets free radicals produced by irradiation in the presence of O_2 to permit these radicals to move and form cross-links. High temperatures induced thermal degradation in the polymers. The optimum conditions of heat treatment, which improves the effect of irradiation, are presented. (TSS)

36286 RADIATION INDUCED SOLID STATE POLYMERIZATION OF MALEIMIDES IN BINARY SYSTEM. Yamakita, Hiromi (Government Industrial Research Inst., Nagoya, Japan); Hayakawa, Kiyoshi; Tanaka, Sumitak. Kogyo Kagaku Zasshi; 73: 819-24 (Apr 1970). (In Japanese).

Radioinduced solid-state polymerization of binary systems of N-phenylmaleimide−acenaphthylene, N-laurylmaleimide−acenaphthylene and N-laurylmaleimide−acenaphthene was studied. Eutectics were formed in all of these binary systems. Elementary analysis, x-ray diffraction and turbidimetric titration of the polymer indicated that the solid-state polymerization in the phenylmaleimide−acenaphthylene system substantially consists of homcpolymerization of each component. In the laurymaleimide−acenaphthylene system, it was shown that the rate of polymerization reached a maximum with the eutectic composition and that the turbidimetric titration curves for the products were different from those for the homopolymers. The x-ray diffraction analysis showed that the product formed in the eutectic was almost amorphous, while polylaurylmaleimide was crystalline. From these results and composition of the products, it was concluded that homopolymers and a copolymer with no long block sequences are produced in this system, and that the copolymerization proceeds in a phase where the monomer molecules are mobile to some extent. For the laurylmaleimide−acenaphthene system, the effect of the unpolymerizable component, acenaphthene, on the polymerization was discussed. (auth) (NSA of Japan)

36287 EFFECT OF MAGNETIC FIELD ON RADIATION INDUCED SOLID STATE POLYMERIZATION OF ACETALDEHYDE AT LOW TEMPERATURES. Mori, Koichi; Tabata, Yoneho; Oshima, Keiichi (Tokyo Univ.). Kogyo Kagaku Zasshi; 73: 815-18(Apr 1970). (In Japanese).

The radioinduced solid-state polymerization of acetaldehyde was studied at −130 and −196°C under a magnetic field of 0 to 6,000 gauss. Since the polymerization of acetaldehyde is greatly affected by impurities and by crystal structure of the monomer, the purification and maintenance of the monomer were undertaken very carefully. The yield of polymerization at −196°C decreased with increasing magnitude of the magnetic field from 0 to 6,000 gauss. The effect of magnetic field on yields in the in-source polymerization was larger at −196 than at −130°C. The radioinduced post-polymerization of acetaldehyde carried out at −130°C not affected by the magnetic field were measured. IR and x-ray diffraction spectra of polymers obtained under the influence of the magnetic field are shown. The experimental results seem to suggest that the magnetic field affects mainly the initiation stage of the solid state polymerization at low temperature, though the mechanism is not obvious at present. Some possible mechanisms are presented to explain the experimental results. (auth) (NSA of Japan)

36288 RADIATION-INDUCED POLYMERIZATION OF MALEIMIDES IN SOLID STATE. Yamakita, Hiromi; Hayakawa, Kiyoshi (Government Industrial Research Inst., Nagoya, Japan). Kogyo Kagaku Zasshi; 73: 604-7(Mar 1970).

Radioinduced polymerization of N-substituted maleimides in the solid state was studied at 70 and 38°C. The in-source polymerization seemed to proceed in a nonstationary state, and the rates of polymerization were in the following order: ethyl- >phenyl- ≈ methyl- >lauryl- >H- >p-methoxyphenyl-maleimide. The polymer yield in the post-polymerization, with the exception of that in the latter stage, was expressed by the equation $Y = A \cdot \log(1 + B \cdot t)$. The rates of post-polymerization of the maleimides were in the fol-

lowing order: ethyl- >methyl- >phenyl- ≈ lauryl- >H- >p-methoxyphenyl-maleimide. No polymer was obtained by the irradiation of p-methoxyphenylmaleimide in the solid state. Thus the susceptibility of the N-substituted maleimides to polymerization by γ-irradiation was quite different from that in the liquid state. These results suggest that the geometric arrangement of the monomer molecules in crystals plays an important role in the solid state polymerization of the maleimides. The x-ray diffraction study showed that the polymers formed in the solid state, except polymaleimide, had two marked interplanar spacings, i.e., the spacing of about 5 Å common to all the crystalline polymers and the larger spacing which increased with the size of the substituents. (auth) (NSA of Japan)

36289 THERMO-STABILIZATION OF POLYTETRAFLUOROETHYLENE OBTAINED BY RADIATION INDUCED POLYMERIZATION. Fujioka, Shuji (Toray Industries, Inc., Otsu, Japan); Shinohara, Yasuo; Nakamura, Tadashi. Kogyo Kagaku Zasshi; 73: 838-41(Apr 1970). (In Japanese).

The decomposition mechanism of polytetrafluoroethylene obtained by radioinduced polymerization was estimated from its decomposition gas and its thermo-stabilization was investigated since its thermostability is inferior to that of commercial polytetrafluoroethylene obtained by catalyst-induced polymerization. Since the decomposition took place only in the presence of O_2 and the gas evolved was CO_2, it seemed reasonable to assume that chain end peroxide radicals were formed by the reaction of chain end radicals (two types radicals may be considered, an unterminated propagating one and a chain end one, which is produced by the decomposition or a weak point in the polymer main chain) with O_2, and these radicals then thermally decomposed to release CO_2. Both the end radical treatment and the elimination of O_2 or some impurities in the monomer were performed for the thermostabilization. A polymer that does not decompose below 400°C was obtained by a double polymerization technique, which consists of removing the prepolymer, which is less than 10%, after the first polymerization and polymerizing the unreacted monomer in the second polymerization. (auth) (NSA of Japan)

36290 PULSE RADIOLYSIS IN CANADA. Boyd, A. W.; Seddon, W. A. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Chem. Can.; 22: 47-9(May 1970). (AECL-3507).

Pulse radiolysis has revolutionized radiation chemistry and made important contributions to other branches of chemical kinetics. A number of Canadian laboratories are now participating in this rapidly expanding field. (auth) (Canada)

36291 ELECTRON SPIN RESONANCE STUDIES OF IRRADIATED NITROUS OXIDE. Smith, D. R.; Seddon, W. A. (Atomic Energy of Canada, Ltd., Chalk River, Ont.). Can. J. Chem.; 48: 1803-11(15 Jun 1970). (AECL-3545).

The γ radiolysis of N_2O at 77°K, or vapor-phase irradiation with 1-MeV He^+ ions followed by condensation at 77°K, results in the formation and trapping of at least 4 paramagnetic species. Using isotopically labeled N_2O these are identified as N_2O^+, NO_2, NO_3, and N. The latter assignment is reasonable on spectroscopic grounds but since this species arises exclusively from the central nitrogen of N_2O it is difficult to describe its formation from established chemical reactions. The addition of H_2O to the vapor phase experiments resulted in the trapping of O^-, while the addition of tetranitromethane or NO indicated the existence of O_2^- and O atoms, respectively. Possible reaction mechanisms are indicated. (auth) (Canada)

36292 THERMAL ANNEALING OF CRYSTALS OF SODIUM CYANONITROSYLFERRATE IRRADIATED BY NEUTRONS. Rusi, A.; Calusaru, A.; (Inst. of Atomic Physics, Bucharest). Radiochim. Acta; 13: 95-9(1970). (In French).

The initial retention of radioiron after neutron irradiation of the sodium pentacyanonitrosylferrate is 32.9% when the product with two molecules of water of crystallization was employed and 31.5% for the product when water of crystallization was absent. The thermal annealing of the radioiron in these systems follows a kinetic model where for each isotherm a certain value of the pseudo-plateau is obtained. Gradual increasing of the retention began at 95°C in the hydrated crystals and at 115°C in the anhydrous crystals. In the recoil product the ratio between Fe(III) and Fe(II) has a constant value characteristic to each isotherm. The initial value of this ratio is equal to 11 in the presence and to 6 in the absence of water of crystallization. In both cases a linear decrease in the ratio Fe(III)/Fe(II) as a function of the temperature occurs. The annealing reaction of Fe(II) is preceded by an oxydation reaction: Fe(II) → Fe(III) → Fe(III) complex. This reaction was established in previous works for the cases of potassium trioxalatoferrate and sodium cupferrate. (auth)

36293 EFFECT OF IRRADIATION ON FLUORINATED SILICA-ALUMINA CATALYST. Sano, Masakatsu; Hoshino, Toshio; Yotsuyanagi, Takao; Aomura, Kazuo (Hokkaido Univ., Sapporo). Kogyo Kagaku Zasshi; 73: 484-7(Mar 1970). (In Japanese).

The activity of a fluorinated silica-alumina catalyst during cumene cracking increases considerably upon γ-irradiation. The activity of the irradiated catalyst corresponds to the strength of electric spin resonance. It is clear from the results described above that the active sites on the silica-alumina catalyst used in the cumene cracking depend on the defects produced in the catalyst upon irradiation. The distributions of the acid strength of the irradiated and nonirradiated catalysts were quite similar; however, the acid content in each acid strength showed a slight increase upon irradiation. From infrared spectroscopy of the fluorinated catalysts, activated at 300°C for 2 hr in vacuum and heat treated at 500°C for 4 hr in atmosphere, the NH_4^+ ion was observed in both catalysts. Further discussions were made on the acidity of the fluorinated catalysts. (auth) (NSA of Japan)

36294 IMPROVEMENTS IN OR RELATING TO PROTECTING SECURITIES AGAINST FORGERY. Dalton, Francis Leonard; McCann, John David (to United Kingdom Atomic Energy Authority). British Patent 1,193,511. 3 Jun 1970. Filed 21 Jun 1967.

A method of protecting securities against forgery is described specifically designed for application to any security as a certification marking indicating that the security is valid for some specific purpose. An area of radiation-sensitive printing ink or paint is provided on the security, and certification is made on the basis of colour changes produced by electron beam radiation. Two classes of printing ink or paint may be used, the first comprising a radiation-sensitive dye dispersed in an inert carrier, and the second a radiation-sensitive carrier together with a dye that detects changes in the carrier. As an example of the first class methylene blue and a cellulose derivative as carrier may be used. It is preferred, however, to use inks or paints of the second class, incorporating a halogen-containing polymer such as polyvinyl or polyvinylidene chloride, which is sensitive to radiation, together with an indicator that changes colour in the presence of liberated HCl. Irradiation may be effected by a scanning technique or by a fixed beam through a mark or a combination of these techniques. A protective coating may be provided over the radiation sensitive area to protect it from uv light. Application to the central GIRO payment system is described in detail. (UK)

36295 INCREASING OF MOLECULAR WEIGHT OF POLYTETRAFLUOROETHYLENE OBTAINED BY RADIATION INDUCED POLYMERIZATION. Fujioka, Shuji (Toray Industries, Inc., Otsu, Japan); Shinohara, Yasuo; Nakamura, Tadashi. Kogyo Kagaku Zasshi; 73: 832-5(Apr 1970). (In Japanese).

The relationship between molecular weight and polymerization solvents, which may decrease the molecular weight of polytetrafluoroethylene by a chain transfer reaction was investigated. It was found that high molecular weight ($>10^7$) polymers can be obtained using the solvents $CClF_3$ and CCl_2F_2, which have no H atoms. From a consideration of the effect of various solvents on the polymerization it may be concluded that extraction by the propagating radical is apt to occur in the following order: $H \gg Cl > F$. Irradiation polymerization was carried out at −40°C. After 10 min, the polymerization yield and the molecular weight was 4.5% and 6.5×10^5, respectively. After this, post-polymerization was carried out by raising the temperature gradually to room temperature. After 3 hrs, the yield and the molecular weight were 97.2% and 1.35×10^7, respectively. The G-value ($-C_2F_4$) in this experimental condition was 10^6. (auth) (NSA of Japan)

36296 MOLECULAR WEIGHT OF POLYTETRAFLUOROETHYLENE OBTAINED BY RADIATION INDUCED POLYMERIZATION. Fujioka, Shuji (Toray Industries, Inc., Otsu, Japan); Shinohara, Yasuo; Nakamura, Tadashi. Kogyo Kagaku Zasshi; 73: 828-31(Apr 1970). (In Japanese).

The molecular weight of polytetrafluoroethylene prepared by γ-induced polymerization in $CHClF_2$ at low temperature was measured by the standard specific gravity method, and the relationship between molecular weight and both the polymerization conditions and polymerization mechanisms are discussed kinetically. Furthermore, the relationships between molecular weight and both the transformations and the cracks in baked samples are discussed. The molecular weights of polymers obtained by radiation induced polymerization are 1.2×10^6 at the maximum, but, contrarily, those of the commercial polymers obtained by catalytic polymerization are in the range 1.7×10^6 to 2.1×10^7. Molecular weights increase linearly not only with irradiation time, but also show a remarkable increase with post polymerization. Furthermore, molecular weights show a rapid increase with increase in the post-polymerization yields. On the basis of these results, the variation of molecular weights was treated kinetically, and

it was found that the relationships between the degree of polymerization ($\bar{P}$) and the irradiation time (t), the rate constant of propagation (k_p) and the monomer concentration ([M]) might be written as follows: $\bar{P} = k_p[M]t$. (auth) (NSA of Japan)

36297 RADIATION INDUCED SOLUTION POLYMERIZATION OF TETRAFLUORETHYLENE IN CHLORODIFLUOROMETHANE AT LOW TEMPERATURE. Fujioka, Shuji (Toray Industries, Inc., Otsu, Japan); Shinohara, Yasuo; Nakamura, Tadashi. Kogyo Kagaku Zasshi; 73: 824-7(Apr 1970). (In Japanese).

Radioinduced solution polymerization of tetrafluoroethylene in $CHClF_2$ under the influence of γ rays from ^{60}Co at −40 to −78°C was carried out and the polymerization mechanism was elucidated kinetically. The rate of polymerization was found to be accelerated with time, and post-polymerization took place in this polymerization system. The rate of polymerization was so fast that the G-values ($-C_2F_4$) were 5.1×10^4 under irradiation and more than 3.3×10^5 during post-polymerization. Further, the rate of polymerization was found to be proportional to the 0.8th power of the dose rate of irradiation, which is near 1.0. On the basis of these data, it may be concluded that this polymerization system is a typical nonstationary-state polymerization system in which the termination reaction is negligibly slow. (auth) (NSA of Japan)

36298 MEANS FOR IRRADIATING MATERIALS. Norman, John Roy (to T.I (Group Services) Ltd.). British Patent 1,193,822. 3 Jun 1970. Filed 18 Jun 1966.

A system is described to provide a means of achieving polymerization or combination reactions in an economic manner by the use of electron radiation of relatively low energy at a low effective dose rate on an overall scale that is commercially practical. The method is continuous in operation and comprises passing the material in a linear path at a substantially uniform rate past at least four spaced beams of high-energy electrons, all the beams having the same order of energy, so that the material is exposed to at least four successive doses of radiation of the same order of energy. The duration of each dose is shorter than the time interval between successive doses and the speed of travel is such that the time intervals between successive doses are greater than the half lifetime of the free radicals induced in the material by irradiation. The process is of particular value in the curing of systems of unsaturated polymers such as unsaturated polymers blended with unsaturated monomers, such as styrene, applied as liquid films to manufactured materials. Examples are described of various applications of the process. All the electron beams may be located on one side of the path of the material and the material may take the form of a flat strip. The material may be in the form of a liquid coating on a manufactured material and may comprise a blend of a polymer with a crosslinked monomer. (UK)

36299 RADIOLYSIS OF DICARBOXYLIC ACID LITHIUM SALT WITH NEUTRON IRRADIATION. Okamoto, Jiro (Japan Atomic Energy Research Inst., Tokai). J. Nucl. Sci. Technol. (Tokyo); 7: 306-11(Jun 1970).

A series of dicarboxylic acids of $Li-(CH_2)_n(COOLi)_2$, n=0 to 6, i.e., Li oxalate, malonate, succinate, glutalate, adipate, and pimelate, was irradiated with mixed radiations in a nuclear reactor to study the decarboxylation and the reaction of labeling with T atoms brought about by the exposure of lithium salts of dicarboxylic acid to neutrons. The T-labeled hydrocarbons were determined by radio gas chromatography, while gaschromatography was used to measure macroscopic amounts of compounds. The gaseous products of radiolysis produced from the neutron irradiation of lithium salts of dicarboxylic acids were CO_2, CO, and hydrocarbons. The yield of CO_2 from the different dicarboxylic acid lithium salts was higher than obtained from γ irradiation, and decreased with increasing number of methylene groups in the original salt. Also, while with γ radiolysis, CO was only generated in negligibly small amounts, it was found quite significant in the case of neutron irradiation. The yield of tritiated hydrocarbon was proportional to the number of methylene groups in the salt molecule. Hydrocarbon was mainly produced by the decarboxylation of the original compounds. Several kinds of degradated hydrocarbon were also observed from the mass peaks as also from activity peaks. (auth)

36300 GAS CHROMATOGRAPHIC ANALYSIS OF γ-IRRADIATED NITROBENZENE FOR BIPHENYL AND NITROAROMATIC PRODUCTS. Knight, J. A. (Georgia Inst. of Tech., Atlanta). J. Chromatogr.; 48: 526-9(6 May 1970).

A study of the γ radiolysis of nitrobenzene necessitated methods for the analysis of the irradiated nitrobenzene for biphenyl, the 3 isomeric dinitrobenzenes, the 3 isomeric nitrobiphenyls, and the 6 isomeric dinitrobiphenyls, which were considered to be likely radiolytic products. It was found that biphenyl and the dinitrobenzenes could be analyzed as a group; the nitrophenyls as a group; and the dinitrobiphenyls as a group by gas chromatography. The optimum conditions for the analysis of these groups are tabulated. Chromatograms of various samples are given. (B.L.M.)

36301 ^{131}I EXTRACTION PROCESS. (to Atomic Energy of Canada Ltd.). British Patent 1,193,599. 3 Jun 1970. Priority date 8 Oct 1968, Canada.

A method and apparatus are described for the preparation of ^{131}I by irradiating encapsulated high-purity slugs of TeO_2 with neutrons for a selected time, removing the slugs from the capsules, melting the TeO_2 in an enclosed space, and collecting the $^{131}I_2$ vapor uncontaminated with TeO_2. The slugs are irradiated for ~4 weeks, and the irradiated TeO_2 slugs are heated to ~750°C to evolve the I_2. The heating is maintained for ~4 hr, and an air flow is used to sweep out the evolved I_2. (B.L.M.)

36302 CHEMICAL BEHAVIOR OF CHROMIUM RECOIL ATOMS PRODUCED IN VARIOUS CHROMATES UNDER LOW TEMPERATURE IRRADIATION. Yeh, Si Jung (National Tsing Hua Univ., Taiwan); Shibata, Nagao; Amano, Hiroshi; Yoshihara, Kenji; Yang, Mo Hsing; Chen, Tsai Feng; Chen, Chin Tsang; Kudo, Hiroshi. J. Nucl. Sci. Technol. (Tokyo): 7: 300-5(Jun 1970).

The role of the water of crystallization and the effects of the cations on the initial retention and the thermal annealing of ^{51}Cr were investigated for chromates of K, Na, Mn, and Tl, which were irradiated at dry ice temperature. It was found that thermal annealing took place below room temperature. A hitherto unnoted effect found in the thermal annealing process of sodium chromate quadrahydrate was dehydration during the thermal annealing process. (auth)

36303 PARAMAGNETIC RELAXATION OF SILVER SPECIES IN γ-IRRADIATED FROZEN AQUEOUS SOLUTIONS. Bales, Barney L. (Univ. of Kansas, Lawrence. San Fernando Valley State Coll., Northridge, Calif.); Kevan, Larry. J. Chem. Phys.; 52: 4644-53(1 May 1970).

Paramagnetic relaxation of Ag^0 and Ag_2^+ in γ-irradiated frozen aqueous solutions of $AgNO_3-KF$ and of Ag^0 in γ-irradiated frozen methanol containing AgF was studied at 77°K. $(T_1T_2)^{-1/2}$ was measured by slow-passage progressive saturation of the absorption signal, and T_1 was measured approximately by fast-passage experiments on the dispersion signal which were extrapolated to adiabatic conditions. The spin-lattice relaxation times T_1 were directly related to the isotropic coupling constant of the silver species. This suggests that the spin-lattice interaction involves the extent of spin delocalization onto the matrix molecules. The variation of $(T_1T_2)^{-1/2}$ with radiation dose was investigated and interpreted in terms of the spatial distribution of Ag^0 and Ag_2^+. Some spatial nonuniformity exists, but it is not as great as previously found for the trapped-electron precursors of the silver species in 10M NaOH ice. (auth)

36304 1969 ANNUAL REPORT. CONFERENCE ON ELECTRICAL INSULATION AND DIELECTRIC PHENOMENA, BUCK HILL FALLS, PENNSYLVANIA, OCTOBER 20–22, 1969. Washington, D. C.; National Academy of Sciences (1970). 204p. $15.00. (CONF-691042).

Twenty-eight papers are included; one paper was abstracted separately in NSA. The remaining 27 papers contain information on breakdown, charge storage, dielectric properties, photoelectric effects, and conductivity measurements on various inorganic and organic materials. (P.C.H.)

For an abstract of one paper see: 36305.

36305 DIELECTRICS WITH PREDICTABLE RADIATION RESPONSE. Conrad, Edward E. (Harry Diamond Labs., Washington, D. C.). pp 21-4 of 1969 Annual Report. Conference on Electrical Insulation and Dielectric Phenomena, Buck Hill Falls, Pennsylvania, October 20–22, 1969. Washington, D. C.; National Academy of Sciences (1970).

See CONF-691042.

A review on radiation response in organic dielectrics concluded that the observation of highly mobile short-lived carriers in liquid organic dielectrics is now possible. Furthermore the capability exists to vary the free carrier lifetime by the removal or introduction of a specific impurity. The proved feasibility of these techniques constitutes a major step toward a better understanding of radioinduced conductance in organic dielectrics. (P.C.H.)

36306 ELECTRON SPIN RESONANCE SPECTRUM OF THE TRIPHENYLSILYL RADICAL FORMED BY THE X-IRRADIATION OF MONOCRYSTALLINE TRIPHENYLSILANE. Geoffroy, M.; Lucken, E. A. C. (Univ., Geneva). Helv. Chim. Acta; 53: 813-18(1970).

The ESR spectrum of x irradiated monocrystalline triphenylsilane has been studied at room temperature. The main radical species present is the triphenylsilyl radical, formed both as isolated radicals and pair-wise trapped radicals. For the radical

pairs the analysis of the dipole coupling tensor indicates an interradical distance of 7.36 Å. The ^{29}Si hyperfine tensor has been determined, and the values discussed in terms of the electronic structure of the triphenylsilyl radical. (auth)

36307 ELECTRON PARAMAGNETIC RESONANCE STUDY OF ALKYLIMINO RADICALS OBTAINED BY PHOTOINDUCED DECOMPOSITION OF AMINOALKYL RADICALS IN ADAMANTANE. Wood, David E. (Carnegie-Mellon Univ., Pittsburgh); Lloyd, Roger V.; Pratt, David W. J. Amer. Chem. Soc.; 92: 4115-17(1 Jul 1970).

Aminoalkyl radicals were produced by room-temperature x-irradiation of a solid pellet of zone-refined adamantane containing added amines. Immediately following the recording of the EPR spectra, the sample was irradiated in situ with light from a 1-kW compact-arc Hanovia Hg–Xe lamp, and a second, entirely different spectrum was obtained. No EPR signal was obtained if light irradiation was used without previous x-irradiation. (M.C.G.)

36308 ELECTRON SCAVENGING IN γ-IRRADIATED LIQUID METHANOL AND ETHANOL. Rzad, Stefan J.; Fendler, J. H. (Carnegie–Mellon Univ., Pittsburgh). J. Chem. Phys.; 52: 5395-5403(15 May 1970).

Electron scavenging in liquid methanol and ethanol was examined as a function of $^{14}CH_3Br$ and SF_6 concentration in the region from 10^{-5} to 0.3 M. The empirical scavenging model previously proposed for hydrocarbons can be successfully extended to alcohols if a competitive first-order reaction of the solvated free electron is included. Solvated free-electron and geminate-electron yields were determined to be 1.05 and 3.1. Analysis of the data from competitive experiments leads to an estimation of the absolute rate constants for reaction of solvated electrons with CH_3Br, CH_3Cl, SF_6, N_2O, and acetone in methanol and ethanol and to an estimation of the half life of the solvated free electrons in both solvents. The present results in ethanol can be correlated with the observations of Thomas and Bensasson on the nanosecond decay of solvated electrons in terms of an ion-pair lifetime distribution function similar to that applicable to hydrocarbon radiolysis. (auth)

36309 ADSORPTION AND CATALYSIS UNDER IRRADIATION. Coekelbergs, R.; Crucq, A. (Institut Interuniversitaire des Sciences Nucleaires, Brussels). pp 244-61 of Symposium on Electronic Phenomena in Chemisorption and Catalysis on Semiconductors, held in Moscow, July 2–4, 1968. /Hauffe, K. (ed.). Berlin; Walter de Gruyter and Co. (1969). (In French).

See CONF-680729.

Results are given for studies on the effects of irradiation by photons (uv, x, and γ) on: the sorption of CO, O_2, CO_2, and H_2 by Al_2O_3; the sorption of O_2 by ZnO and the conductivity of ZnO; and the catalysis of the oxidation of CO by various semiconductors. The results are interpreted in the framework of the electronic theory of catalysis. This theory insists on certain facts that are not explicable in the actual framework of the theory, in particular: the phenomenon of direct desorption that seems to be general enough; and the fact that the photoadsorption seems to be produced on certain particular sites, thermally inactive, but photoactivable. (tr-auth)

36310 SITES OF ATTACK OF HYDROXYL RADICALS ON AMIDES IN AQUEOUS SOLUTION. Hayon, E.; Ibata, T.; Lichtin, N. N.; Simic, M. (Army Natick Lab., Mass. Boston Univ.). J. Amer. Chem. Soc.; 92: 3898-3903(1 Jul 1970).

The reactivity and sites of attack of radiolytic hydroxyl radicals on simple amides in aqueous solution were studied. The following amides were examined: formamide (F), N-methylformamide (NMF), N,N-dimethylformamide (DMF), acetamide (A), N-methylacetamide (NMA), and N,N-dimethylacetamide (DMA). The rate constants for reaction of OH radical with NMF, DMF, NMA, and DMA fall in the range $(1.0-3.5) \times 10^9$ M^{-1} sec^{-1}, but the reactivity with F and A is significantly lower. The absorption spectra in the wavelength range 225 to 600 nm and the specific rates of decay of the transient species produced by the reaction of OH radicals with amides were determined and their structures assigned. With F and A, OH radicals attack at both sites on the molecule to give HCONH, $CONH_2$, CH_3CONH, and CH_3CONH_2 radicals. With the N-methylated amides, abstraction by OH radicals takes place mainly from the N-methyl group, e.g., $OH + CH_3CON(CH_3)_2 \rightarrow CH_3CON(CH_2)(CH_3) + H_2O$. The implications of these results with respect to the radiolysis of peptides are discussed. (auth)

36311 CHEMICAL EFFECTS ASSOCIATED WITH THE THERMAL NEUTRON IRRADIATION OF LIQUID ANILINE. Barakat, M. F.; Zahran, A. H. (Atomic Energy Establishment, Cairo). Isotopenpraxis; 6: 95-8(Mar 1970).

Carbon-14 labeled organic compounds formed upon thermal neutron irradiation of liquid aniline have been studied. Some aspects of the structural dependence of the recoil carbon-14 atom reactions in liquid systems have been investigated by comparing the data obtained upon thermal neutron irradiation of aniline with those obtained in case of irradiated pyridine and its homologues. Some of the product-forming mechanisms are discussed. (auth)

36312 NUCLEAR RECOIL REACTIONS IN ORGANOMANGANESE COMPOUNDS. IV. FULVALENEHEXACARBONYLDIMANGNESE. DeJong, I. G.; Wiles, D. R. (Carleton Univ., Ottawa). Can. J. Chem. 48: 1614-15(15 May 1970).

The chemical effects of neutron capture were studied in fulvalenehexacarbonyldimanganese, in order to determine whether or not the ring–ring bond survives nuclear recoil. Retention in the parent form (9.1%) is comparable to that in other organomanganese compounds, while the radiochemical yield of $CpMn(CO)_3$, the "monomer," is very much lower (0.2%). This suggests that the inter-ring bond is not broken under the conditions in the reaction zone. The formation of radiomanganese compounds with several carbonyl ligands (4.7%) is in accord with mass spectrometric evidence, which suggests that CO may be readily available in the reaction zone. (auth) (Canada)

36313 RHODIUM CARRIER-FREE EXTRACTION FROM HYDROCHLORIC MEDIUM WITH TRIBUTYL PHOSPHATE. Stella, Renato; Carini, Giuseppe (Univ., Pavia, Italy). Ric. Sci.; 39: 654-7(Jul-Sep 1969).

Rhodium-105 carrier-free extraction was investigated using TBP as extractant. Under certain conditions rhodium-105 was found to form an extractable species with iodide ions. These conditions are given for Rh separation from fission products. (auth)

36314 REACTIONS OF TRITIUM RECOIL ATOMS IN n-HEXANE–BENZENE BINARY MIXTURES. Avdonina, E. N.; El Zakhir, Adnan; Nesmeyanov, An. N. Vestn. Mosk. Univ., Ser. II, Khim.; 11: 42-5(Jan-Feb 1970). (In Russian).

Reactions of tritium recoil atoms in benzene and hexane mixtures of various compositions in various aggregate states and in the presence of iodine were studied. The hexane mixtures with benzene and with or without 5×10^{-3} mole/l iodine were irradiated by a thermal neutron flux of 1.2×10^{13} neutrons/cm^2/sec for 15 min at 70°C and by 9×10^{11} neutrons/cm^2/sec for 2 hr at –170°C. The main products of the reaction of tritium recoil atoms in hexane were HT (nearly 55%) and the labeled mother compound (~29%), the products of broken alkane molecules and high-boiling fractions containing 11 and 7%, respectively, of the total amount of labeled products. It was shown that the yield of HT and labeled gaseous products depend linearly on the concentration of the mixtures. The data obtained were in agreement with published results of studies on cyclohexane–benzene indicating high similarity of processes initiated by tritium recoils in cyclic and aliphatic hydrocarbons. (R.V.J.)

36315 DISTRIBUTION OF REACTION PRODUCTS. VI. HOT-ATOM REACTIONS, T + HR. Kuntz, P. J.; Nemeth, E. M.; Polanyi, J. C.; Wong, W. H. (Univ. of Toronto). J. Chem. Phys.; 52: 4654-74(1 May 1970).

A three-atom model has been employed in a first study of the dynamics of the reactions of hot tritium with hydrogen-containing organic molecules, e.g., T + CH_4. After exploring many extended-London–Eyring–Polanyi–Sato (LEPS) potential-energy hypersurfaces, a surface was obtained which was in qualitative accord with experiment in that it predicted predominantly abstraction at the low end of the hot-atom range of energies (taken to be 2 eV). Abstraction (ABS) consists in T + HR → TH + R; displacement (DIS): T + HR → TR + H; fragmentation (FRAG): T + HR → T + H + R. The model was employed in a computer study of the 3-D classical dynamics of abstraction, displacement, and fragmentation in the prototype reaction T + HR and in isotopic variants D + HR, T + DR, and T + HR′ (masses H = 1, D = 2, T = 3, R = 15 and R′ = 31 amu). The quantities calculated were the total reactive cross section as a function of collision energy (2 to 18 eV), the partial reactive cross section as a function of the initial THR angle α, and the partial reactive cross section as a function of the initial impact parameter b. In addition, product vibrational, rotational, and translational energy distributions, and product angular distributions, were computed. The principal findings were (i) that the abstraction and displacement both constituted direct (as opposed to complex) and concerted (in contrast to sequential) reactions. The outcome of a particular reactive encounter depended on a delicate balance between strong repulsive forces, and, consequently, was no easier to predict for these hot-atom reactions than for thermal ones. (ii) Displacement was favored at intermediate collision energy (4 to 6 eV) because of the moderating effect that attraction from the heavy R group produced in the speed

of T. (iii) At high energies (≳ 7 eV) a new, stripping, reaction path opened up which made abstraction again dominate displacement; consequently, over all, the mean collision energy for abstraction exceeded that for displacement. This is in accord with recent experiments. (iv) In general, translational energy in the products accounted for the largest part of the collision energy, with a fairly broad energy distribution. (v) At 2 to 4 eV collision energy the peak of the angular distribution for the molecular product was sideways following abstraction, backwards following displacement; higher collision energy shifted both peaks (especially abstraction) in the forward direction. (vi) Fragmentation accounted for only a few percent of the total reaction at collision energies 25% in excess of that required for formation of T + H + R, but at higher energies (≳7 eV) was comparable in importance to abstraction. (vii) At 2 to 4-eV collision energy the cross section for abstraction decreased when T was replaced by a mass equivalent to D, H by D, or R by R′. The cross section for displacement also decreased when T was replaced by D, or H by D (providing further evidence of concerted reaction), and increased when R was replaced by R′. (auth)

36316 PULSE RADIOLYSIS STUDIES. XVII. REACTION KINETICS OF MOLECULAR CATIONS OF AROMATIC COMPOUNDS IN DICHLOROETHANE SOLUTION. Shank, Norman E.; Dorfman, Leon M. (Ohio State Univ., Columbus). J. Chem. Phys.; 52: 4441-7(1 May 1970).

Fast reaction studies of the kinetics of molecular cations of aromatic molecules, formed by irradiation of the aromatic compounds in 1, 2-dichloroethane solution, provided quantitative information about the modes of formation and of decay of these molecule ions. Specific reaction rates were determined for the electron transfer from a neutral aromatic molecule to an aromatic cation for three donor-acceptor pairs. The rate of formation of the aromatic cation, thought to be a charge transfer from the aromatic molecule to the solvent cation, is so high as to suggest that migration of the solvent cation is not a process of molecular diffusion, but involves an electron jump process in the solvent. The decay of the aromatic cation appears to be due largely to recombination with the counterion. Absolute rate constants for electron transfer between the aromatic pairs studied are at or near diffusion controlled, with values ranging from 5.1×10^9 to $9.9 \times 10^9 \underline{M}^{-1}$ sec^{-1} at 25°C. (auth)

36317 EFFECT OF PRESSURE ON THE RADIATION-INDUCED CONDUCTANCE OF LIQUID HYDROCARBONS. Brazier, D. W.; Freeman, G. R. (Univ. of Alberta, Edmonton). Can. J. Chem.; 47: 885-92(15 Mar 1969).

An attempt was made to test the cavity model of electron localization in liquid hydrocarbons by measuring the effect of pressures up to 4000 bars on the radiation induced conductance of n-pentane, n-hexane, n-octane, cyclopentane, methylcyclohexane, and 2,2-dimethylbutane at 30°C. Measurements at 3 and 56°C were also made on n-hexane and n-octane. The relative induced conductance, i.e., the ratio of the induced conductance at pressure p to that at 1 bar, decreased with increasing pressure. The amount of decrease was slightly greater at low than at high temperatures. The behavior of 2,2-dimethylbutane was complex and is not understood. For the other liquids, it was concluded that the free ion yields remained constant or decreased somewhat with increasing pressure. An appreciable increase in the free ion yields, which is a possible implication of the cavity model of electron localization, did not occur. Therefore, either (a) the cavity model of electron localization in hydrocarbons is wrong, or (b) application of pressures up to 4000 bars did not appreciably alter the cavity concentrations in the liquids. Perhaps the cavity concentration is greatly reduced only by pressures great enough to cause a solid phase (glass or crystal) to form. (auth) (Canada)

36318 KINETICS FOR FREE-RADICAL CONVERSION PROCESSES IN IRRADIATED D,L-VALINE. Horan, Paul Karl; Henriksen, Thormod; Snipes, Wallace (Univ. of California, Berkeley). J. Chem. Phys.; 52: 4324-8(1 May 1970).

The kinetics for two free-radical conversions in irradiated D,L-valine was studied by use of electron spin resonance (ESR) spectroscopy. In D,L-valine three different radicals are observed. At 77°K only one of these radicals R(1)[the radicals induced at 77°K are referred to collectively as R(1)] is formed, which upon subsequent warming converts into the intermediate radical R(2)[$(CH_3)_2$ $\dot{C}HCOOH$] with an efficiency of approximately unity. The reaction, studied in the temperature range 110 to 125°K, was found to be first order with an activation energy of 7.6 ± 0.2 kcal/mole. Upon further warming, a third radical R(3)[$(CH_3)_2\dot{C}\underset{H}{\overset{NH_3^+}{C}} - COO^-$] is formed. This formation consists of two separate processes, each proceeding by first-order kinetics. The activation energies, measured in the temperature range 200 to 260°K, are 6.6 ± 0.3 kcal/mole and 8.3 ± 0.5 kcal/mole, with the smaller activation energy process occurring at slightly lower temperatures. It was found that the concentration of R(3), as observed after warming to 300°K, was significantly greater than the initial concentration of R(1). This increase in total radical concentration is associated with the production of R(3) by the process having an activation energy of 6.6 kcal/mole. Possible mechanisms for the conversions are discussed in light of the known structures of R(2) and R(3). (auth)

36319 FORMALDEHYDE YIELD IN IRRADIATED D-FRUCTOSE. Loefroth, Goeran; Kim, Chul (Univ., Stockholm). Acta Chem. Scand.; 24: 749-50(1970).

The solid D-fructose was irradiated at room temperature, with ^{60}Co γ-rays at a dose rate of 4×10^{19} eV/g. After dissolution in water and precipitation of the keto compounds formed with 2,4-dinitrophenylhydrazine, the yield of formaldehyde was determined by a gas chromatographic method. The yield followed an exponential dose response, which may be expressed as yield = constant × (dose)^2 with a constant of 4.5×10^{-24} molecules HCHO × g × (eV)$^{-2}$. (Denmark)

36320 EFFECT OF TEMPERATURE ON YIELDS IN THE RADIOLYSIS OF NITROUS OXIDE WITH HIGH INTENSITY ELECTRON PULSES. Boyd, A. W.; Willis, C.; Miller, O. A. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. J. Chem.; 47: 351-2(15 Jan 1969). (AECL-3179).

Nitrous oxide was irradiated with single electron pulses at a dose rate of 0.8×10^{27} eV/g s at temperatures between 24 and 500°C. The gas yields showed no dependence on temperature below 200°C but above this $G(N_2)$ increased and $G(O_2)$ decreased. The yields were found to be independent of dose up to 4×10^{20} eV/g. (auth) (Canada)

36321 CARBON MONOXIDE YIELDS IN THE RADIOLYSIS OF CARBON DIOXIDE AT VERY HIGH DOSE RATES. Willis, C.; Boyd, A. W.; Bindner, P. E. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. J. Chem.; 48: 1951-4(1 Jul 1970). (AECL-3595).

Carbon dioxide was irradiated with electron pulses at a dose rate of 2×10^{27} eV g^{-1} s^{-1}. The measured carbon monoxide yield is $G(CO) = 7.8 \pm 0.3$. Addition of SF_6, an electron scavenger, reduces this yield to $G(CO) = 4.8$ which is the same, within the experimental error, as the low dose rate yield $G(CO) = 4.5 \pm 0.5$. The effect of SF_6 and the difference between the high and low dose rate yields is explained by suppression of dissociative neutralization of the $C_2O_4^+$ ion. (auth) (Canada)

36322 HOT-ATOM CHEMISTRY OF BROMINE. IV. CHEMICAL EFFECTS OF ^{81}Br(n,γ)^{82g}Br, ^{81}Br(n,γ)^{82m}Br, AND ^{82m}Br (I.T.)^{82}Br EXCITATION IN ANTIMONY TRIBROMIDE AND BENZENE SYSTEM. Kishikawa, Toshiaki; Aratono, Yasuyuki; Shinomiya, Chiro (Kumamoto Univ., Japan). Bull. Chem. Soc. Jap.; 43: 1276-82(May 1970).

Antimony tribromide and a molecular compound between antimony tribromide and benzene (2:1) were irradiated to provide ^{82m}Br sources. The results obtained by the dissolution of the irradiated molecular compound, by means of which the chemical effects of ^{81}Br(n,γ)^{82g}Br and ^{82m}Br(I.T.)^{82}Br were determined separately, showed very low organic yields from either (n,γ) or (I.T.) excitation. The reaction of ^{82m}Br(I.T.)^{82}Br in benzene showed a growth in the organic yields. Moreover, the organic yield of ^{82}Br was lower when the system was frozen than when it was stored as a liquid. These results are explained by assuming that, in the frozen system, the antimony tribromide (^{82m}Br) forms a molecular compound with the benzene. The higher organic yields in the frozen systems than those in the molecular compound itself must be due to the formation of free bromine (^{82m}Br), which turns out to be an organic radiobromide. The hydrolytic behavior of the irradiated antimony tribromide and the molecular compound supports the idea of the presence of free bromine (^{82m}Br) at the end of the irradiation. (auth)

36323 ELECTRON SPIN RESONANCE SPECTRA OF ^{15}N-LABELLED AMINO RADICALS. Smith, D. R.; Seddon, W. A. (Atomic Energy of Canada, Ltd., Chalk River, Ont.). Can. J. Chem.; 48: 1938-42(15 Jun 1970). (AECL-3587).

Electron spin resonance (ESR) spectra of radiolytically formed $^{15}NH_2$ and $^{15}ND_2$ radicals are presented along with their hyperfine splitting constants and spectroscopic g factors. A comparison with previously observed spectra of $^{14}NH_2$ and $^{14}ND_2$ is briefly discussed and their hyperfine parameters revised as a result of our ^{15}N data. Miscellaneous observations on the effect of additives (water, methyliodide, tetranitromethane) are discussed. (auth) (Canada)

36324 STUDIES IN THE FIELD OF POLYETHYLENE. IV. INFLUENCE OF γ-RADIATION ON THE STRUCTURE AND MOLECULAR WEIGHT OF THE AS [AMYLSODIUM] POLY-

ETHYLENE. Isacescu, D. A.; Ionescu, I. V.; Kenyeres-Ursu, V.; Petrus, I.; Furnica, Gh.; Caragheorgheopol, A. (Inst. of Macromolecular Chemistry, Bucharest). Eur. Polym. J.; 6: 609-25 (1970).

A study was made of effects of ^{60}Co γ radiation on the average molecular weight and the structure of AS polyethelene obtained with amylsodium catalyst. Examination was made of the viscosimetric characteristics and the ir and electron spin resonance (ESR) absorption spectra for samples irradiated at room temperature and in the presence of air. The spectra were recorded immediately after irradiation and after various lengths of storage at different temperatures. The ionizing radiation caused an oxidative degradation of AS polyethylene, shown by the decrease of the average molecular weight and the appearance of characteristic ir absorption bands for oxygen-containing groups. The ESR spectra indicate the existence of allyl, alkyl, and polyenyl radicals. During storage of the irradiated AS polyethylene especially at high temperature (80°), a slight increase in the oxidative degradation process can be observed. (auth)

36325 THERMAL BEHAVIOR OF ^{60}Co IRRADIATED CELLULOSE. Byrne, Geoffrey A.; Arthur, Jett C. Jr. (Southern Regional Research Lab., New Orleans). Text. Res. J.; 40: 577-8(Jun 1970).

Cotton cellulose print cloth was treated in air at about 23°C with ^{60}Co γ radiation; the dose rate of the source was 1.15 Mrad/hr. The irradiated samples were thermally analyzed within less than 24 hr. TGA and DTA were conducted in vacuum at a heating rate of 5°/min. The results showed that when cotton cellulose was irradiated to dosages greater than 1 Mrad, there was a decrease in thermal stability of the cellulose. At a dosage of 19 Mrads, the cellulose was highly degraded. However, cellulose irradiated to a dosage of 1.0 Mrad had about the same thermal stability as unirradiated cellulose. The DTA curves of samples of cellulose, irradiated to dosages greater than 1 Mrad, showed that the temperature corresponding to the onset and the peak of the endotherm progressively decreased as the initial decomposition temperature of the cellulose decreased. (P.C.H.)

36326 RADICAL RECOMBINATION IN γ-IRRADIATED ANTHRACENE. Ringel, H. (Queens Coll., Flushing, N. Y.).; Whitten, W. B.; Damask, A. C. Mol. Cryst. Liquid Cryst.; 6: 435-7(Feb 1970).

Anthracene was exposed to 10^9R of ^{60}Co γ radiation and the products analyzed by gas chromatography. Several new substances were found in concentrations proportional to the radiation dose, some with molecular weights of at least twice that of anthracene. Only one major substance eluted prior to anthracene. This material was identified as dihydroanthracene. A reaction is proposed in which two dibenzocyclohexadienyl radicals combine to form one dihydroanthracene molecule and one anthracene molecule. (D.H.M.)

36327 UNSTABLE INTERMEDIATES. PART LXVIII. ELECTRON SPIN RESONANCE STUDIES OF THE RADICALS O_3PF^- AND O_2PF_2. Begum, Afrozi; Subramanian, S.; Symons, M. C. R. (Univ. of Leicester, Eng.). J. Chem. Soc., A; No. 8, 1323-6 (1970).

The radicals O_3PF^- and O_2PF_2, both isoelectronic with PO_4^{3-}, were identified by their characteristic ESR spectra. The former was prepared by γ irradiation of KPO_2F_2 crystals containing PO_3F^{2-} impurity, and the latter by similar treatment of POF_3 containing HPO_2F_2. Magnetic data for PO_3F^- were $g_{\parallel} = 2.0274$, $g_{\perp} = 2.0085$; $A_{\parallel}(^{31}P) =$ ca. $A_{\perp} =$ ca. 39.1 G, $A_{\parallel}(^{19}F) \approx A_{\perp} =$ ca. 8.0 G. The radical O_2PF_2, which was rotating relatively rapidly at 77°K, had $g_{av} = 2.0100$, $A_{iso}(^{31}P) = 43.8$ G, and $A_{iso}(^{19}F) = 52.5$ G The results are discussed in terms of structures in which the unpaired electron is confined to a molecular orbital on the three oxygen atoms of O_3PF^-, but delocalized on to both the oxygen and fluorine atoms in O_2PF_2. The steady increase in $A_{iso}(^{31}P)$ on going from PO_4^{3-} to O_2PF_2 is explained in terms of a σ-bond spin-polarization mechanism. (auth) (UK)

36328 RADIOCHEMICAL POLYMERIZATION OF ACRYLIC ACID IN LIQUID AND SOLID PHASE. II. DISCUSSION OF POLYMER TYPES. Chapiro, A.; Sommeriatte, T. (CNRS, Bellevue, France). Eur. Polym. J.; 5: 725-45(1969). (In French).

The poly(acrylic acids) obtained in the first part of the study were subjected to selective extraction in dioxane (solvent for the atactic polymer) and thereafter in a dioxane–water mixture (solvent for the stereoregular polymer). An insoluble residue (gel) was found in all cases. Liquid phase polymerization chiefly led to the formation of a stereoregular polymer which was insoluble in dioxane. This polymer was found to crystallize and the crystals were examined with optical and electronic microscopes and submitted to x-ray diffraction. The x-ray diagrams were different from that of the isotactic poly(acrylic acid), known from the literature, but similar to that of a syndiotactic polymer prepared by synthesis. Irradiation of the crystalline monomer led to three different polymer fractions which were respectively the atactic and syndiotactic polymers and a gel. In the presence of various additives, the syndiotactic polymer fraction increased in importance except with acetic acid where it decreased. Careful drying of the monomer prior to irradiation led to the formation of the atactic polymer. These various results are discussed. The polymerization kinetics of liquid acrylic acid were very similar to those found with acrylonitrile. Both reactions involved free radical polymerizations in which the termination step was hindered by the precipitation of the polymer. The kinetics of the solid state polymerization were similar to those observed with acrylamide. An unexpected result was the fact that irradiation of the liquid monomer at temperatures of 20 to 76° led to the formation of a syndiotactic polymer. In contrast, in the crystalline state, the dry monomer was converted to essentially atactic polymer. With small amounts of water or other additives present, the mixtures at 1° were constituted of pure monomer crystals and of a liquid solution, since all additives investigated formed low melting eutectic mixtures. The polymer arising in this liquid phase was syndiotactic except in the case of acetic acid. It was assumed that liquid acrylic acid, like other carboxylic acids, formed association dimers and that in these complexes the two monomer molecules lay in planar symmetry. The polymerization of such dimeric structures could lead to the syndiotactic polymer. Acetic acid, which replaced the monomer in the associations thereby prevented the formation of a regularly alternating polymer. (auth)

36329 REACTIONS OF ^{80}Br ACTIVATED BY ISOMERIC TRANSITION IN THE GASEOUS PHASE. THE ISOTOPIC VARIATION BETWEEN CH_4 AND CD_4. Tachikawa, Enzo; Kahara, Toshiki (Japan Atomic Energy Research Inst., Tokai). Bull. Chem. Soc. Jap.; 43: 1293-7(May 1970).

The roles of the excess kinetic energy and the thermal ionic processes in the reaction of the ^{80}Br from the isomeric transition of ^{80m}Br in gaseous CH_4 and CD_4 were investigated using a rare gas additive. A possible isotope effect has appeared on the substitution reaction of the energetic Br atom to form $CH_3{}^{80}Br$ or $CD_3{}^{80}Br$, but not on the thermal processes to form $CH_3{}^{80}Br$ and $CH_2{}^{80}BrBr$ or their isotopic alternatives. At a zero mole fraction of moderator, the $CH_3{}^{80}Br/CD_3{}^{80}Br$ ratio for the energetic process was found to be 2.7 ± 0.3. This is consistent with the moderator and/or probability integral isotope effects. However, in a highly moderated system the results indicated that the former effect is more important than the latter. Furthermore it can be inferred from the total pressure effects on the energetic reaction products that the excited primary products are able to decompose unimolecularly due to internal excitation. (auth)

36330 RADIOLYSIS AND PHOTOLYSIS OF METHANOLIC SOLUTIONS OF EOSIN. I. THE γ-RADIOLYSIS OF NEUTRAL AND ALKALINE SOLUTIONS. Kimura, Kazuie; Miwa, Takuji; Imamura, Masashi (Inst. of Physical and Chemical Research, Yamato, Japan). Bull. Chem. Soc. Jap.; 43: 1329-36(May 1970).

The γ-radiolysis of eosin was studied in deaerated neutral and alkaline methanolic solutions. Eosin is reduced principally with CH_2OH radicals in dilute solutions. In neutral solutions, G(−eosin) is about 2 at the eosin concentration of 10^{-5} M and increases as the concentration of eosin is increased. The final products are leuco-eosin and an unidentified substance, which has an absorption peak at 455 nm. In an alkaline solution (10^{-5} M), G(−eosin) is about 4 and the product is semireduced eosin, which is stable in the dark and which undergoes photo-debromination. The ESR spectrum of semireduced eosin was also recorded. (auth)

36331 RADIOLYSIS AND PHOTOLYSIS OF METHANOLIC SOLUTIONS OF EOSIN. II. THE PHOTO-DEBROMINATION OF EOSIN IN AN ALKALINE SOLUTION. Kimura, Kazuie; Miwa, Takuji; Imamura, Masashi (Inst. of Physical and Chemical Research, Yamato, Japan). Bull. Chem. Soc. Jap.; 43: 1337-42 (May 1970).

Semireduced eosin was found to undergo photo-debromination and was identified with a precursor in the photo-debromination of eosin in alkaline methanolic solutions. Semireduced eosin was prepared by γ irradiation of an eosin solution. The photolysis of semireduced eosin was investigated by the use of continuous and flash light. From the absorption spectral change and a study of the decay, the mechanism of the photo-debromination was proposed. The debromination process of the photo-excited semireduced eosin was explained satisfactorily by assuming the transient formation of the debrominated-eosin σ-radical as an intermediate. In addition, an electron-transfer reaction from semireduced debrominated eosin to eosin, which results in the formation of semireduced eosin and debrominated eosin in the

dark, was noted. A general conclusion as to the photo-dehalogenation of xanthene dyes is also given. (auth)

36332 SUSPENSIONS OF PHTHALOCYANINE COMPLEXES AS THE TARGET MATERIAL FOR RAPID SEPARATION OF RADIOCHEMICALLY PURE FRACTIONS OF RARE EARTH METALS FROM SPALLATION PRODUCTS. Pfrepper, G.; Christov, D. (Joint Inst. for Nuclear Research, Dubna, USSR). Kernenergie; 13: 125-7(Apr 1970). (In German).

When suspensions of rare earth phthalocyanine complexes and 0.1 N NH_4Cl solution are exposed to 660-MeV protons, on the average 20 per cent of the spallation products go into the aqueous phase due to their recoil energy and can be separated from the target material within 30 sec. By chromatographic separation on Dowex 50 × 8 using α-hydroxyisobutyric acid as the eluent, radiochemically pure fractions of the rare earth metals are obtainable within 15 to 20 min after the end of bombardment. Their activity is sufficient for measuring them by means of a Ge(Li) detector. Due to the high radiolysis, enrichment factors are smaller than 20 in dependence on bombardment time. (auth)

36333 CATIONIC CHAIN REACTION IN THE RADIOLYSIS OF ETHANOL VAPOR. Bansal, K. M.; Freeman, G. R. (Carnegie-Mellon Univ., Pittsburgh. Univ. of Alberta, Edmonton). J. Amer. Chem. Soc.; 92: 4173-5(15 Jul 1970).

During the radiolysis of ethanol vapor at 350°C and higher temperatures, diethyl ether is formed by a cationic chain reaction. At 380°C, $G(Et_2O)$ decreased from 62 at an ethanol pressure of 85 torr to 2.6 at 1630 torr. The overall activation energy of the chain mechanism was 43 ± 4 kcal/mole, independent of ethanol pressure within experimental error. The values of the rate constants of one or both of the reactions $(EtOH)_mH^+ \rightarrow Et_2O \cdot H^+ \cdot (OH_2)(EtOH)_{m-2}$ (4_m) and $Et_2O \cdot H^+ \cdot (OH_2)(EtOH)_{m-2} + 2EtOH \rightarrow Et_2O + H_2O + (EtOH)_mH^+$ (5_m) decreased with increasing m for $m \geq 2$. The rate of ether formation is reduced by the presence of ammonia, a proton scavenger. The vapor-phase reaction $CH_3O + C_2H_5OH \rightarrow CH_3OH + CH_3CHO$ occurs at 200 to 380° by a thermal mechanism that is not appreciably sensitized by radiation. The rate of the reaction is unaffected by the presence of propylene, a free radical scavenger. (auth)

36334 RADIATION-INDUCED CATIONIC CHAIN FORMATION OF ETHER FROM ISOPROPYL ALCOHOL VAPOR. van der Linde, H. J.; Freeman, G. R. (Univ. of Alberta, Edmonton). J. Amer. Chem. Soc.; 92: 4417-20(15 Jul 1970).

During the γ radiolysis of isopropyl alcohol vapor at temperatures above 250°C, diisopropyl ether is produced by a cationic chain mechanism. The mechanism is zero order with respect to alcohol pressure and has an activation energy of 40 ± 1 kcal/mol independent of pressure over the range studied (100 to 2000 torr). The ether yield decreases with increasing dose and is not dependent on the surface:volume ratio of the reaction vessel. At 350°C 100 torr and 2.9×10^{17} eV/g, G(ether) = 1000; the G value is inversely proportional to the alcohol pressure. The addition of about 10 mol % of the following additives decreased the ether yield by amounts in the following increasing order: water < propylene < sulfur hexafluoride < acetone < ammonia. The proton affinities of the additives increase in the same order. The chain propagation reactions appear to be $(ProH)_mH^+ \rightarrow Pr_2O \cdot H^+ \cdot (OH_2)(Pr_2OH_{m-2})(4_m)$, $Pr_2O \cdot H^+ \cdot (OH_2)(PrOH)_{m-2} + 2PrOH \rightarrow Pr_2O + H_2O + (PrOH)_mH^+$ (5_m). The presence of a foreign (nonalcohol) molecule in the "clustered" ion apparently inhibits reaction 4_m. The addition of >10% propylene to the alcohol sensitizes ether formation, presumably by way of the exothermic reaction $C_3H_7^+ + PrOH \rightarrow C_3H_8 + PrOH_2^+$. (auth)

Radiochemistry

36335 ^{125m}Te MOESSBAUER EFFECT STUDY OF ELECTRON CAPTURE IN CERTAIN ^{125}I COMPOUNDS. Babeshkin, A. M.; Lamykin, E. V.; Lebedev, V. A.; Nesmeyanov, An. N. Vestn. Mosk. Univ., Ser. II, Khim.; 11: 117-18(Jan-Feb 1970). (In Russian).

Spectra of nuclear γ-resonance for ^{125}Te were obtained using the absorber, β-$^{125}TeO_2$, and a ^{125}I source in various chemical forms at liquid nitrogen temperature. Chemical changes caused by electron capture were detected in $NaI \cdot 2H_2O$, KIO_3, and in frozen solutions of NaI in H_2O and $Na_2H_3IO_6$ in 0.1 N HNO_3. (R.V.J.)

Separation Processes

Refer also to abstracts 36142, 36164, 36204, 36269, 36313, 36332, 36479, and 36480.

36336 (CEA-N-1241) SEMIANNUAL REPORT OF THE CHEMISTRY DEPARTMENT NO. 7, DECEMBER 1968-MAY 1969. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Feb 1970. 434p. (In French). Dep. CFSTI (U. S. Sales Only).

Twelve sections are included; separate abstracts were prepared for 10. The remaining two sections contain information on electrochemistry of fused salts and electrocrystallization and miscellaneous chemical studies, including treatment of nonradioactive chemical effluents, elimination of the scaling compounds from seawater, desalting of brackish and seawater by electrodialysis, materials adaptable to the desalting of seawater, and recovery of enriched boron. (P.C.H.)

For abstracts of individual sections see: 36143, 36337-36344, and 36860.

36337 (CEA-N-1241, pp 85-100) INTERMEDIATE AND LOW LEVEL WASTE PROCESSING. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). (In French).

Methods for the concentration and decontamination of low-activity effluents are studied: ion exchange, evaporation by pulsed air, chemical treatments by precipitation, and biological processes. The equipment of the experimental station PETERPAN is described. (France)

36338 (CEA-N-1241, pp 101-13) URANIUM PROCESSING. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). (In French).

The recovery of enriched uranium is described, and results are given. The optimum conditions for transformation of uranium hexafluoride into uranium or uranium dioxide were studied. New techniques for treatment of uranium are discussed: reduction of uranyl nitrate into uranous nitrate; production of frittable uranium dioxide by hydrolysis of UF_6; recovery of uranium with 93% enrichment from U-Al wastes; and production of U_3O_8 standards for emission spectroscopy. (France)

36339 (CEA-N-1241, pp 179-254) STUDY OF AQUEOUS REPROCESSING METHODS: LABORATORY. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). (In French).

Experiments carried out on the dissolution, after boring of Sicral fuels with a graphite core, are reported. In order to increase the decontamination during the reprocessing of fuels by the Purex method, the effects of sulfate and molybdenum ions on the formation of zirconium butyl phosphates were studied. The distribution coefficients of Pu, Zr, Nb, and Ru in the mixture TBP-dodecane were determined with a view to reprocessing Pu-Al fuels. Tests were performed on the application of the fluorine method to remove interphase precipitates. The distribution coefficients of HF in the mixture TBP-dodecane and the distillation of fluorine during the concentration of fission products were studied: aromatic hydrocarbons were used as tridodecylamine diluent. The decantation of tridodecylamine diluted in monoalkylbenzene and the purification of Pu by extraction with TLA diluted in dodecane-alkylbenzene mixtures were investigated. Equipment for hot cells (mixer-settlers and pump) is described. Inactive tests were performed on U-Al fuels in a pilot continuous dissolver. Studies were also made on the operation of centrifuge extractors. (France)

36340 (CEA-N-1241, pp 255-89) STUDY OF AQUEOUS REPROCESSING METHODS: PILOT PLANT. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). (In French).

Studies on the processing of irradiated plutonium-aluminum fuels are described. They include the nitric acid dissolution of the irradiated fuels and the separation of plutonium by extraction with TBP. The recovery of neptunium, on a semi-industrial scale, in the solutions from the UP_2 plant is considered. The neptunium is separated by two extraction cycles with tridodecylamine. Developments made in alpha detection by semiconductor diode are also reported. The activities of the analytical laboratories are summarized. Some analytical methods are given. (France)

36341 (CEA-N-1241, pp 291-324) STUDY OF NONAQUEOUS REPROCESSING METHODS. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). (In French).

Three tests were performed on U-Zr or U-Al alloys in the ATTILA facility. Decontamination factors were determined and the U balance prepared. Studies were also made on the treatment of UO_2-PuO_2 mixed oxides. Volatility processes were developed for the recovery of U and Pu using BrF_3 or fluorine as fluorination agents. (France)

36342 (CEA-N-1241, pp 325-53) PREPARATION AND STUDY OF ACTINIDE ELEMENTS. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). (In French).

The selective extraction of trivalent metallic elements in the presence of tetravalent metallic elements was investigated. The separation coefficients were determined for Am(III) and Pu(IV) using tridodecylamine (40%) or TBP (40%). The results are tabulated. The industrial neptunium-plutonium separation with tridodecylamine was improved by using a reducing $HNO_2-H_2SO_4$ solution. The analytical neptunium-plutonium separation with a mixture tridodecylamine 30%-dodecane 25%-chlorobenzene 35% is described and the procedure given. The americium-curium separation by liquid-liquid extraction was studied. In the countercurrent calculation a new factor, which is the dilution of the nonextracted element by the washing solution, was introduced. The theoretical and experimental separation coefficients are presented. A sol-gel process for preparing ThO_2 sols was developed. It includes three steps: the preparation of the ThO_2 colloidal suspensions; the formation of the microspheres by injection as droplets into a dehydrating solvent; and the calcination of the gelled spheres. The Petrus II cell equipment to process the targets of transuranium elements is described. (France)

36343 (CEA-N-1241, pp 355-73) STUDY OF THE VITRIFICATION OF FISSION PRODUCT SOLUTIONS. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). (In French).

Piver, vitrification pilot plant at Marcoule, is described. It is installed in an extension of the fuel reprocessing pilot plant. The first campaign of vitrification of active fission product solutions is reported and the results given. (France)

36344 (CEA-N-1241, pp 375-425) FUNDAMENTAL STUDIES. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). (In French).

Topics covered include: salting out of neutral molecules in salt-water mixtures; extraction of hydrochloric acid and water by trioctylamine; extraction of trivalent actinide elements by tridodecylamine; spectrophotometry of neptunium in nitric acid medium; properties of hexavalent uranium in basic media; properties of sulfuric complexes of hexavalent neptunium; preparation and properties of complexes of rare earth chlorides with 1, 10-phenanthroline; determination of ^{241}Pu in ^{242}Pu by α-γ coincidence spectrometry; automatization of chemical analyses by injection enthalpimetry; and titration of free acidity in the presence of plutonium and uranium. (France)

36345 (CEA-R-3973) APPLICATION OF ATOMIC ABSORPTION SPECTROPHOTOMETRY TO INDUSTRIAL FABRICATION CONTROLS. Grison, Jean (Commissariat a l'Energie Atomique, La Hague (France)). May 1970. 20p. (In French). Dep. CFSTI (U. S. Sales Only).

At La Hague plant laboratories atomic absorption spectrophotometry is used for analytical control of the process. A special installation for evacuating the liquid and gaseous effluents from the apparatus makes it possible to use this technique both in active and inactive media, without any modification. It is possible to analyze fission product solutions after dilution, and to determine impurities present in uranium solutions. After decontamination, the determination of impurities in PuO_2 and PuF_4 is possible by this technique. (auth) (France)

36346 (DOCKET-50201-38) WEST VALLEY REPROCESSING PLANT. Waste Release and Environmental Monitoring. (Nuclear Fuel Services, Inc., West Valley, N. Y.). 29 Jun 1970. 32p. Dep. CFSTI.

An alternative to deep well disposal of low-level wastes to reduce the quantities and concentrations of the radioactivity released in the low-level effluents is proposed. A proposed stepwise chemical treatment system is described. (M.C.G.)

36347 (DP-Report-107) THE PURIFICATION OF GRAPHITE BY TREATMENT WITH HALOGENS AT TEMPERATURES UP TO 1000°C. Project DRAGON. Horsley, G. W. (Atomic Energy Establishment, Winfrith (England)). Aug 1962. 21p. Dep. CFSTI.

Methods of removing impurities in graphite are discussed. Experimental evidence is presented to show that it is possible at temperatures up to 1000°C to volatilize by iodination impurities of magnesium, calcium, strontium, barium, iron, silicon, and aluminum. Chlorination may be used to volatilize magnesium, silicon, iron, aluminum, vanadium, and titanium. Recommendations are made with regard to the use of such treatments for graphite components in Dragon. (auth)

36348 (EUR-4481) INTRODUCTION TO THE STUDY OF THE PHYSICO-CHEMICAL BEHAVIOR OF RADIORUTHENIUM CONTAINED IN RADIOACTIVE WASTE. Amavis, R. (European Communities, Luxembourg. Commission); Blum, J. M.; Jaumier, J. J.; Verot, J. L. (Ugine-Kuhlmann S. A., Paris (France)). 16 Feb 1970. 46p. (In French). Dep. CFSTI (U. S. Sales Only). EUR FF 7,75.

A great deal of radioactive pollution of the environment is at present due to radioruthenium. Lack of information on the physicochemical behavior of this element makes it difficult to eliminate during purification treatment of radioactive waste. Research has been directed to the identification of the physicochemical form in which ruthenium is present in purified or unpurified waste. Electrophoresis, chromatography, and ion exchange techniques have been used in particular for this work. Different cationic, anionic, neutral, polynuclear, or colloidal forms have been identified. (auth)

36349 (IN-1396) A DIRECT COUNTING METHOD FOR STUDYING THE ADSORPTION OF AQUEOUS $^{233}UO_2^{2+}$ ONTO GLASS SCINTILLATOR SURFACES. Mark, E. L.; Porter, R. A.; Chanda, R. N.; Schuman, R. P. (Idaho Nuclear Corp., Idaho Falls). Jun 1970. Contract AT(10-1)-1230. 77p. Dep. CFSTI.

The adsorption of the uranyl ion, UO_2^{2+}, from aqueous solution onto a glass surface was studied using the ^{233}U isotope as a radiotracer and a cerium activated glass scintillator disc. Adsorption was studied at various values of pH, concentration, and temperature. The activity due only to adsorbed ions was obtained by subtracting the electronic noise and the activity due to uranyl ions in the solution from the observed activity. Kinetic data were taken and fitted with a first order rate law based on Langmuir's Model. The rate constants for adsorption were in the range 1.42×10^{-3} hours^{-1} to 1.82×10^{-2} hours^{-1}. The Arrhenius activation energy at pH 2.0 was on the order of 20 kcal/mole. The surface coverage appears to be on the order of a monolayer or less. (auth)

36350 (IS-T-353) SYNERGIC SOLVENT EXTRACTION AND THERMAL STUDIES OF FLUORINATED BETA-DIKETONE-ORGANOPHOSPHORUS ADDUCT COMPLEXES OF LANTHANIDE AND RELATED ELEMENTS. Mitchell, James Winfield (Ames Lab., Iowa). 1970. Contract W-7405-eng-82. 190p. Dep. CFSTI.

Thesis.

The synergic extraction of lanthanides from an aqueous acetate-chloride medium into cyclohexane solutions containing mixtures of the fluorinated β-diketones, trifluoroacetylacetone (HTFA), hexafluoroacetylacetone (HHFA), 8,8,8,7,7,6,6-heptafluoro-2,2-dimethyl-3,5-octanedione (HFOD), and tributyl phosphate (TBP) was studied. The extraction properties of the compounds, 1,1,1,5,5,6,6,7,7,7-decafluoro-2,4-heptanedione (HFHD), 1,1,1,2,2,6,6,7,7,8,8,8-dodecafluoro-3,5-octanedione (HDODEFOD), tris (2,2,2-trifluoroethyl) phosphate (TFEP), and tris (3,3,3,2,2-pentafluoropropyl) phosphate (PFPP), were also investigated. Mole ratio studies and measurements of the dependence of the distribution equilibria on pH, ligand, and adduct concentrations indicated that species of composition, $R.E.(A)_3 \cdot 2TBP$, where A is the anion of the ligand and R.E. represents the rare earth cation, were extracted into the organic phase. The synergic system, HHFA-TBP, was found to possess extraction properties necessary for a subsequent gas chromatographic determination. Rare earths at micro and macro levels (10^{-4} to 10^{-2} M) were rapidly and quantitatively converted to the corresponding mixed chelates under pH conditions such that hydrolysis of the cations in the aqueous phase did not occur. The stoichiometry of the complexes extracted into solutions of HHFA-TBP in cyclohexane remained constant for the lanthanide series. Analytical extraction curves were measured for Th(IV), Sc(III), U(VI), U(IV), Ca(II), Y(III), Fe(III), Zn(II), Cu(II), and some lanthanide elements. The utility of the extraction systems, HTFA in benzene, HTFA-TBP in cyclohexane and HHFA-TBP in cyclohexane, for analytical separations of Sc(III), Fe(III), UO_2^{2+}, and Th(IV) from the rare earths and of the rare earths from Al(III) was demonstrated. Conditions for the separation of certain cations from each other and from the rare earths using HTFA are suggested. Trends in thermal stability and volatility of chelates of the lanthanide and related elements were obtained from thermogravimetric analysis of the hydrated and mixed chelates. Significant improvements in thermal stability of rare earth chelates were obtained by displacement of water of hydration upon adduct formation with TBP. (auth)

36351 (KURRI-TR-73) BASIC STUDIES ON THE TREATMENT OF RADIOACTIVE LIQUID WASTES BY THE FLOTATION METHOD. Koyanaka, Yoshio (Kyoto Univ. (Japan). Research Reactor Inst.). Mar 1970. 100p. (In Japanese). Dep. CFSTI (U. S. Sales Only).

Studies were made on the separation and removal of fission products from intermediate- and low-level liquid wastes by the flotation method ordinarily used for ore concentration. Basic studies were first made on the coprecipitation of fission products with chemical precipitates and on the flotation of chemical precipitates. Then, based on the results obtained, long-lived fission products, such as ^{137}Cs, ^{90}Sr, ^{144}Ce, ^{106}Ru, and ^{95}Zr, were subjected to the flotation treatment, in an attempt to clarify separation characteristics of the respective radionuclides. Subsequently, the feasibility of the method for intermediate- and low-level liquid wastes was investigated, and also on the selective flotation treatment to obtain separately the long- and short-lived fission products from the fuel-repressing liquid waste. Studies were also made on the practical method of its application for treatment of radioactive liquid wastes, the radioactive-substance decontamination factors, the form of radioactive sludges, and the method of reducing the sludge volume. (NSA of Japan)

36352 (LA-4436) CALCIUM AS A SOLUBLE GETTER FOR THE CONTROL OF OXYGEN IN SODIUM SYSTEMS. Rodgers, D. N.; Meadows, G. E.; Biery, J. C. (Los Alamos Scientific Lab., N. Mex.). Apr 1970. Contract W-7405-eng-36. 13p. Dep. CFSTI.

The feasibility of using calcium as a soluble getter for the control of impurity concentration levels in a sodium system was evaluated in a series of experiments in which calcium metal was added to an operating sodium system of 7.5-gal capacity. The system was operated in both the cold-trapped and isothermal modes. In the 125 to 350°C range the [Ca] · [O] concentration product was found to vary between 0.13 and 0.22 ppM^2. Thus, 1 ppM calcium in solution will maintain an oxygen concentration below 0.22 ppM in this temperature range. Calcium was also observed to adsorb on stainless steel and nickel surfaces. Surface concentrations on stainless steel between 0.01 and 0.04 mg/cm^2 were found. The adsorbed calcium was lightly bound and available for gettering oxygen. In the calcium additions made in these experiments, 80% of the calcium added could not be accounted for and disappeared into unknown sinks. This work indicated that calcium may have promise as a soluble getter of oxygen in sodium. (auth)

36353 (MLM-1728) STABLE GASEOUS ISOTOPE SEPARATION AND PURIFICATION: JANUARY–MARCH 1970. (Mound Lab., Miamisburg, Ohio). 15 Jul 1970. Contract AT(33-1)-Gen-53. 32p. Dep. CFSTI.

Progress on carbon isotope separation is summarized. The production of ^{13}CO by distillation and $^{13}CH_4$ by thermal diffusion is discussed. A computer program was developed to calculate thermal-diffusion-column transport coefficients for liquids based on tables of physical properties as functions of temperature. It was tested on both gases and liquids. The elemental carbon system was adapted to handle the reaction, $CO_2 + Zn \xrightarrow{400°C} CO + ZnO$. A trial run showed this to be a workable system for the conversion of carbon-13-labeled carbon dioxide to carbon monoxide. Progress on the thermal diffusion separations of He, Ne, Ar, Kr, and Xe isotopes is reported. Helium contaminants were removed from the argon system by freezing the argon on charcoal at 77°K and evacuating the helium. Diffusion coefficients for the CH_4-CO_2 system were measured at 295 to 370°K. Measurement of thermal diffusion factors for equimolar mixtures of ^4He and ^3He was extended into the temperature range of 41 to 4.2°K. (J.G.B.)

36354 (ORNL-4472) LOW-LEVEL RADIOACTIVE WASTE TREATMENT: THE WATER RECYCLE PROCESS. Yee, W. C.; DeLora, F.; Shockley, W. E. (Oak Ridge National Lab., Tenn.). Jul 1970. Contract W-7405-eng-26. 30p. Dep. CFSTI.

The water recycle process was developed for decontaminating low-level radioactive aqueous wastes and recycling the purified water for reuse at nuclear installations. This process was successfully demonstrated through several cycles in a micro-pilot plant, using ORNL waste that contained low concentrations of salts and radionuclides. The recycle of water should be an improvement over present methods in which the wastes are decontaminated and the purified water is discharged to the environment. The steps in the process are: (1) clarification, using zeta-potential-controlled additions of coagulants such as alum, coagulant aids, activated silica, and nonionic organic polyelectrolyte; (2) demineralization by cation-anion exchange; and (3) treatment with activated carbon. Zeta-potential control was shown to be an excellent method for obtaining optimum clarification conditions. The water in the micro-pilot plant was decontaminated from all major radionuclides by factors (DF's) of 1000 to 10,000 for up to 2400 volumes of water per volume of cation resin. The DF's for cobalt (^{60}Co) and ruthenium (^{106}Ru) were 10^4 and 10^3, the highest obtained in the ORNL waste development program. (auth)

36355 (ORNL-4586, pp 50-66) MOLTEN SALT BREEDER STUDIES. (Oak Ridge National Lab., Tenn.).

Research progress is reported on: reductive extraction studies, other separations, tritium behavior, and graphite. (M.C.G.)

36356 (ORNL-4586, pp 98-117) NUCLEAR SAFETY. (Oak Ridge National Lab., Tenn.).

Studies are reported on: steam–graphite reactions, in-pile behavior of fuel elements, iodine behavior in fuel capsules, aerosol filtration, radioiodine trapping in fuel reprocessing plants, aging of impregnated charcoals, fuel rod failure, and iodine-absorbing spray solutions. (M.C.G.)

36357 (ORNL-TM-3034) CHEMICAL APPLICATIONS OF NUCLEAR EXPLOSIONS (CANE). Progress Report, January 1–March 31, 1970. Arnold, W. D.; Crouse, D. J. (comps.) (Oak Ridge National Lab., Tenn.). 16 Jun 1970. 22p. Dep. CFSTI.

The ^{106}Ru contamination of copper metal products prepared in electrowinning tests was directly dependent on the ^{106}Ru concentration in the cell electrolyte. The results of initial evaluation tests with Kelex 100, a newly available copper extractant, indicated that the radioactive contamination should be very low in copper products recovered with this reagent from liquors obtained by leaching nuclear-broken ore. The tritium contamination of oil shale or retorted oil was the same after exposure of the shale to tritiated water vapor at 85°C for 1 year as after exposure for 29 days. However, increasing the exposure time of the shale to tritiated hydrogen from 25 to 44 days increased the contamination of the shale and oil by about 80%. In exposure tests made in sealed glass flasks at atmospheric pressure, the tritium contamination was lower when the exposure atmosphere was nitrogen than when it was air. The exposure atmosphere in steel pressure vessels had no effect on the tritium contamination. About 87% of the tritiated hydrogen was removed from a shale sample by treating it for 14 days at 200°C with a moist gas stream. Minor operational problems were encountered during testing of the procedure for the fractionation of natural gas samples. In the first analysis of a Gasbuggy gas sample, specific activities of the separated components were about 6% lower than the values reported by Lawrence Radiation Laboratory. More than 98% of the tritiated ethane was removed from contaminated kerosene by sparging it with air. (auth)

36358 (TID-25452) ION-EXCHANGE SELECTIVITY OF THE SYNTHETIC ZEOLITE LINDE A IN ANHYDROUS AND MIXED MEDIA. Barrett, R. B.; Marinsky, J. A. (State Univ. of New York, Stony Brook. Dept. of Chemistry). [1970]. Contract AT(30-1)-2269. 27p. Dep. CFSTI.

The selectivity coefficients for the ion exchange of cesium with sodium A-zeolite and cesium and sodium with potassium A-zeolite were determined in nonaqueous and mixed media. The exchanging ions were at radioactive tracer level concentrations so that the fraction of the macro-ion of the zeolite was essentially unity in both the zeolite and external liquid phase. The dramatic increase in ion-selectivity at very high alcoholic content of the liquid phase could only be qualitatively examined and was attributed to the significant solvation of the zeolite by the alcohol in the alcohol-rich media. Quantitative interpretation of the data obtained in the mixed media prior to this sharp increase in selectivity was attempted by assuming that the zeolite phase may be treated as a highly concentrated electrolyte solution having only one diffusible ion and as a cross-linked network which exerts a pressure on the internal solution phase. The special properties of the zeolite, rigidity, resistance to electrolyte incursion and high selectivity for water were believed to permit recourse to this model in mixed media over an alcohol–water weight percent composition ranging from 0 to 70. Correlation of experimental and calculated selectivity points was sufficiently good to support the validity of this approach. (auth)

36359 (WASH-1154) EVALUATION OF MINOR ISOTOPE SAFEGUARD TECHNIQUES (MIST) IN REACTOR FUEL PROCESSING. (Nuclear Fuel Services, Inc., West Valley, N. Y.). 20 Feb 1970. Contract AT(38-1)-539. 65p. Dep. CFSTI.

Data from fuel reprocessing operations were collected for evaluation of a number of experiments designed to aid in safeguarding nuclear fuels from the time of irradiation to packaging after chemical reprocessing. The processing sequence, input measurements, product measurements, material balance report, and process data are discussed. (M.C.G.)

36360 EXTRACTION OF MOLYBDENUM FROM COAL ASH BY HCl SOLUTIONS. Mirzakarimov, A. M. (Inst. of Chemistry, Tashkent). Uzb. Khim. Zh.; No. 1, 68-70(1970). (In Russian).

Efficient extraction of Mo oxides from coal ash by 5% HCl solutions was achieved. The yield of Mo after treatment for 1 min at 20°C was 88.96% and after 10 min, 90.54%. (R.V.J.)

36361 COMPLEXES OF LANTHANUM AND ACTINIUM WITH FLUORIDE, OXALATE, AND SULPHATE IN AQUEOUS

SOLUTIONS. Aziz, A.; Lyle, S. J. (Univ. of Kent, Canterbury, Eng.). J. Inorg. Nucl. Chem.; 32: 1925-32(Jun 1970).

Equilibrium constants for complexes formed by lanthanum and actinium ions with fluoride, oxalate and sulfate are reported for an aqueous sodium perchlorate medium of ionic strength 0.5. A partition method making use of di-2-ethylhexylphosphoric acid in toluene was employed in this work. The values obtained are discussed in relation to data available for yttrium, other lanthanides and actinides. (auth) (UK)

36362 EQUILIBRIUM DISTRIBUTION OF ACTINIDE AND LANTHANIDE ELEMENTS BETWEEN MOLTEN FLUORIDE SALTS AND LIQUID BISMUTH SOLUTIONS. Ferris, L. M.; Mailen, J. C.; Lawrance, J. J.; Smith, F. J.; Nogueira, E. D. (Oak Ridge National Lab., Tenn.). J. Inorg. Nucl. Chem.; 32: 2019-35(Jun 1970).

The equilibrium distributions of several actinide and lanthanide elements between liquid bismuth solutions and a variety of LiF-containing molten fluoride salts were determined between 500 and 700°C. At each temperature, the distribution coefficients (mole fraction in bismuth phase divided by mole fraction in salt) obeyed the relationship $D = (D_{f_i})\ K'$, in which n is the valence of the element in the salt phase. Over the range of conditions investigated, Th, Pa, and Zr existed as tetravalent species in the salt; U, Np, Pu, Am, Cm, Cf, La, and Nd were trivalent; Eu was divalent. The distribution behavior of each element was affected by salt composition and temperature. Values of log K' increased regularly with decreasing temperature. With $LiF-BeF_2-ThF_4$ (72-16-12 mole %) as the salt phases the values of log K' at 600°C for the trivalent actinide elements varied systematically with atomic number, and passed through a minimum near Z = 96(Cm). (auth) (UK)

36363 FLOCCULATION TREATMENT OF RADIOACTIVE CONTAMINATED SEA WATER. I. EXPERIMENTAL STUDIES ON FLOCCULANTS. Sakurai, Akira; Nagaoka, Yukio; Wadachi, Yoshiki (Japan Atomic Energy Research Inst., Tokyo). Nippon Genshiryoku Gakkaishi; 12: 317-21(1970). (In Japanese).

The decontaminability and the optimum conditions were studied on the flocculation of radioactive contaminated seawater containing radioisotopes of fission product components. Flocculation is one of the best methods of treating high-salt-content liquid waste. The results obtained showed that ^{137}Cs and ^{106}Ru were removed to the extent of 99% with 500 ppM of copper ferrocyanide $\{Cu_2[Fe(CN)_6]\}$ floc at pH 5 to 6, while ^{144}Ce, ^{147}Pm and $^{95}Zr-^{95}Nb$ were also removed by 99% with 500 ppM of calcium phosphate $[Ca_3(PO_4)_2]$ floc at pH 10 to 11, and $^{90}Sr-^{90}Y$ could be removed to an extent of over 90% with 2,000 ppM of $Ca_3(PO_4)_2$ accompanied with 500 ppM of $Sr(NO_3)_2$ at pH 10 to 11. Addition of a high polymer coagulant, polyacrylamide, did not enhance at all the decontaminability of the flocculation. It may possibly be effective in the treatment of flocculation sludge to support the growth of sedimentation floc. (auth)

36364 SYNERGISTIC EFFECTS IN THE $HNO_3-UO_2(NO_3)_2$-D2EHPA-TBP SYSTEM. Bykhovtsov, V. L. Radiokhimiya; 12: 412-13(1970). (In Russian).

It is shown that in contrast to the previously studied system $H_2SO_4-UO_2(SO_4)-DEHPA-TBP$, the synergistic effect in the $HNO_3-UO_2(NO_3)_2-DEHPA-TBP$ system takes place in the whole organic phase saturated with uranium. Moreover, the synergism coefficient increased with increasing uranium concentration in the organic phase. The relationship between the synergism coefficient in the $HNO_3-UO_2(NO_3)_2-DEHPA-TBP$ system uranium concentration > 0.25 mole U/mole DEHPA is tabulated and analyzed. (R.V.J.)

36365 CALCINATION EXPERIENCE WITH SOME EFFLUENTS FROM A FUEL REPROCESSING PLANT. Franceschini, A. (SORIN, Saluggia, Italy); Bongioanni, G.; Balestrini, A. Energ. Nucl.; 17: 371-8(Jun 1970). (In Italian).

Residues from nuclear fuel reprocessing are among the most important radioactive effluents of the nuclear industry. The decontamination of such effluents by pot evaporation, followed by calcination at 500 to 600°C, was studied. Results were satisfactory: the escape of radionuclides from the pot is generally limited to 0.1 to 1 per thousand: activity released is recovered almost quantitatively in the condensate; the final residue is a granular solid with density about 1 g/cm^3; the volume reduction factor is about 4 to 10. (auth)

36366 SYNTHESIS AND ION-EXCHANGE CHARACTERISTICS OF TITANIUM ANTIMONATES. Qureshi, Mohsin; Kumar, Virendra (Aligarh Muslim Univ., India). J. Chem. Soc., A; No. 9, 1488-91(1970).

Titanium antimonate precipitates were obtained by mixing the solutions of 0.1-M titanium(IV) chloride and 0.1-M antimony pentachloride in the volume ratio of 1:1 at different pH values. Adsorption studies of 21 cations were made on all the samples synthesized. The selectivity of this ion exchanger for metal ions was compared with other synthetic inorganic ion exchangers. (auth) (UK)

36367 AMINE EXTRACTION OF PROTACTINIUM(V) AND THORIUM(IV) FROM AQUEOUS ORGANIC ACID MEDIA. Abdel-Gawad, A. S.; Maghrawi, H. B.; Sherif, S. A.; Abdel-Rassoul, A. A. (Atomic Energy Establishment, Cairo). J. Inorg. Nucl. Chem.; 32: 2079-82(Jun 1970).

Studies are described on the extraction of Pa(V) and Th(IV) by a variety of tertiary amines and quaternary ammonium salts from aqueous media containing organic acids, including citric, oxalic, and acetic acids. ^{233}Pa and ^{234}Th were used in the studies, and the amines investigated included tripropylamine, tridodecylamine, trioctylamine, and Alamine, together with the structurally related tertiary amines Adogens 363, 364, 368, 381, and 382. The quaternary ammonium salt investigated was tricaprylmethylammonium chloride (Aliquat 336). Chloroform, benzene, xylene, and odourless kerosene were used as diluents. Results are tabulated. Pa(V) was almost quantitatively extracted from citric acid solutions (0.08 to 4.8N) and from oxalic acid solutions (0.05 to 0.8N) by all the amines, except tripropylamine; it was not extracted from acetic acid solutions by any of the tertiary amines, but was extracted from this medium by Aliquat 336. Increased citric acid concentration resulted in a considerable decrease in extraction of Th(IV) for all the tertiary amines and for Aliquat 336. In general, low-molecular-weight tertiary amines were less efficient extractants than their higher homologues. The stability of the extracted species depended mainly on the basicity of the amine. The effect of oxalate ion concentration on the distribution coefficient of Pa(V) was also studied. (UK)

36368 TREATMENT OF SOLID RADIOACTIVE WASTE AT THE NUCLEAR RESEARCH CENTRE KARLSRUHE. Hempelmann, W.; Krause, Helmut (Gesellschaft fuer Kernforschung mbH, Karlsruhe, Ger.). Chem.-Ing.-Tech.; 42: 645-53(May 1970). (In German).

The solid radioactive waste products at the nuclear research center in Karlsruhe are about 60% burnable. They are burnt in an experimental ashing plant that was installed in 1963. The reduction in volume is about 1:77. The ash is bound in cement and can be stored without danger. The furnace gases can be purified to respirable concentrations. The unburnable radioactive waste is reduced to about half its original volume by pressing in a hydraulic column press. Since good results in the ashing were obtained with the experimental plant, it is being used as a model for the construction of an operational plant in which an economical processing of waste can be expected at a planned throughput of 50 kg/hr. (auth)

36369 PROBLEMS AND DEVELOPMENTS OF THE PUREX PROCESS FOR THE REPROCESSING OF NUCLEAR FUELS. Baumgaertner, F. (Univ., Heidelberg). Chem.-Ing.-Tech.; 42: 653-8(May 1970). (In German).

Simple variations in the Purex process solved the serious problems that have at times cast doubt on the suitability of the conventional process for the processing of future nuclear fuels. The insolubility of PuO_2 can be overcome by thermal conversion into PuO_2/UO_2 solid solutions. The danger of criticality can be eliminated by use of drum extractors. The resulting reduction in the flow cross-section can be compensated by an increased rate of flow. Radiolytic decomposition of the extracting medium can be avoided by shortening of the contact time during extraction and also by use of rapid extractors. Plutonium/uranium separation is also possible at high plutonium concentrations by a continuous electrolytic method without addition of materials foreign to the process. (auth)

36370 FRACTIONATION FACTOR OF ^{18}O BETWEEN WATER VAPOUR AND ICE. Majoube, M. (CEN, Gif-sur-Yvette, France). Nature (London); 226: 1242(27 Jun 1970).

The fractionation factor was measured over the temperature range -33.4 to 0°C by a steady-state method employing a mass spectrometer specially designed for determination of the isotopic ratio $R = (H_2{}^{18}O)/(H_2{}^{16}O)$, with direct injection of water vapor into the apparatus; the factor was measured directly as $\alpha = R_i/R_v$, where R_i and R_v are the ^{18}O isotopic ratios for ice and water vapor, respectively. The accuracy for a measurement was $\pm 10^{-4}$, and the results could be represented by the relationship $\ln \alpha = 11.839/T - 28.224 \times 10^{-3}$. The ^{18}O fractionation factor between ice and water at 0°C deduced from the results was $\ln \alpha_{ice\text{-}water} = 0.0034 \pm 0.0003$. Comparisons were made with the results of other workers. (UK)

36371 RELATION OF SEPARATION AND ENRICHMENT FACTORS ON ISOTOPE DISTRIBUTION BETWEEN SEVERAL FRACTIONS. Kuznetsova, E. M.; Semiokhin, I. A. Vestn. Mosk. Univ., Ser. II. Khim; 11: 3-9(Jan-Feb 1970). (In Russian).

Equations are given establishing the connection between isotope ^{16}O and ^{18}O composition changes in the initial substance, fractions of conversion of initial substance into various final products, and separation factors by equilibrium isotope distribution among three or four fractions. (auth)

36372 COPRECIPITATION OF PLUTONIUM WITH ZIRCONIUM AND MANGANESE(IV) HYDROXIDES. Novikov, A. I.; Starovoit, I. A. This paper was summarized in At. Energ. (USSR); 27: 218-19(Sep 1969) as paper No. 337/4836. (In Russian).

The coprecipitation of small quantities of Pu in various degrees of oxidation by zirconium hydroxide and manganese hydroxide was studied as a function of the pH of the medium in 1M ammonium nitrate. The process is characteristic of each degree of plutonium oxidation. (M.C.G.)

36373 COMPLEX FORMATION OF Zr(IV) AND Hf(IV) WITH HYDROXAMIC ACIDS IN ACIDIC SOLUTIONS. Fouche, K. F.; Le Roux, H. J.; Phillips, F. (Univ. of the Orange Free State, Bloemfontein, S. A.). J. Inorg. Nucl. Chem.; 32: 1949-62(Jun 1970).

Stability constants for zirconium and hafnium complexes with N-benzoyl-N-phenyl-hydroxylamine (HBPHA), N-cinnamoyl-N-phenylhydroxylamine (HCBPHA), N-2-thenoyl-N-phenyl-hydroxylamine (HTPHA), N-furoyl-N-phenylhydroxylamine (HFPHA) and ethyl-N-terephtaloyl-N-phenylhydroxylamine (HETHA) (indexed as N-hydroxyterephthalanilic acid)were calculated from solvent extraction results employing a least squares method. The HTPHA-complexes, with log $(k_2(Zr)/k_2(Hf) = 1.4$, show the greatest difference in stabilities. Zirconium and hafnium complexes of composition $M(BPHA)_3Cl$ were isolated from organic phases after extracting macro quantities of the metals from solutions more than 5 to 6 M in HCl. The protonation constants for HBPHA, HCBPHA and HTPHA were determined in sulphuric acid solutions by means of solvent extraction. Protonation cannot account for the solubility of hydroxamic acids in hydrochloric and perchloric acid solutions; this may be caused by a salting-in effect of hydrochloric and perchloric acid. (auth) (UK)

36374 NATURAL CALCIUM OXALATE WITH HEAVY CARBON. Hoefs, J. (Zentrallaboratorium fuer Geochemie, Goettingen, Ger.). Nature (London); 223: 396(26 Jul 1969).

The ratios $^{13}C/^{12}C$ and $^{18}O/^{16}O$ for some samples of whewellite ($CaC_2O_4 \cdot xH_2O$) were determined mass spectrometrically, and it was found that this rare mineral undoubtedly contains heavy carbon. If the oxalate in whewellites is biogenic, this represents the first discovery of natural heavy carbon. A fractionation of 20 to 30% was observed. The problem of how fractionation can give the heavy carbon is not known, but partial bacterial decomposition of the oxalate into light CO_2 and heavy residual oxalate may be a possibility. (UK)

36375 SOLVENT EXTRACTION OF HAFNIUM(IV). X. EXTRACTION BY SOME CHELATING AGENTS IN THE PRESENCE OF MONOCARBOXYLIC ACIDS. Hala, J.; Sotularova, L. (Univ. of Brno). J. Inorg. Nucl. Chem.; 31: 2247-55(Jul 1970).

Extraction of hafnium(IV) by benzene solutions of dialkylphosphoric acids, HBPHA(N-benzoyl-N-phenylhydroxylamine), and TTA from 2 M $HClO_4$ medium was studied in the presence of formic, acetic, lauric, and benzoic acids. The decrease in the distribution ratio of hafnium caused by these acids in systems with dialkyl phosphoric acids is shown to be of antagonistic nature due to the interaction in the organic phase of the extracting agent with monocarboxylic acids. In extractions with HBPHA and TTA, acetic acid concentrations higher than 1 M were necessary to cause the distribution ratio of hafnium to decrease, probably on account of the formation of hafnium acetato complexes in the aqueous phase. Spectro-photometric proof is given for the interaction of TTA with acetic acid. (auth) (UK)

36376 IDENTIFICATION OF SUBSTANCES BY PAPER AND THIN-LAYER CHROMATOGRAPHY. 4th International Symposium, Frascati, Italy, September 22-24, 1969. Hais, I. M.; Lederer, M.; Macek, K. (eds.). J. Chromatogr.; 48: 191-392 (22 Apr 1970). (In German and English). (CONF-690956).

There are 26 papers included in the conference proceedings. These papers are divided into the following sections: (1) Reaction before or during chromatography. Formation of derivatives; (2) Chromatography of decomposition products; (3) Combination of paper or thin-layer chromatography with other chromatographic principles; (4) Combination of paper and thin-layer chromatography with other physicochemical methods; and (5) Identification of inorganic compounds. An abstract was prepared for one paper. (B.L.M.)

For an abstract of one paper see: 36156.

36377 SOLVENT EXTRACTION OF SOME TRANSITION ELEMENTS WITH SULPHOXIDES AND PHOSPHINE OXIDES. Shanker, Ramendra; Venkateswarlu, K. S. (Bhabha Atomic Research Centre, Trombay, India). J. Inorg. Nucl. Chem.; 32: 2369-81(Jul 1970).

Transition elements are known to form anionic chloro complexes and some are efficiently extracted by tributyl phosphate (TBP) from hydrochloric acid medium. The solvent extraction characteristics of di-n-butyl sulphoxide (DBSO) are compared with TBP in respect to extraction of Cr(VI), Mn(II), Fe(III), Co(II), Cu(II), Zn(II), and Zr(IV) from HCl solutions. The effects of the organic group on the extraction behavior were studied by exploring the extraction of Fe(III) by diphenyl sulphoxide (DPSO) and triphenylphosphine oxide (TPPO). Possible explanations for the extraction in terms of donor-acceptor interaction are discussed. (auth) (UK)

36378 STUDYING THE OPTIMAL CONDITIONS FOR EXTRACTION OF ZIRCONIUM, HAFNIUM, THORIUM, AND IRON(III) IONS WITH REAGENTS OF ARSENAZO I AND DIPHENYLGUANIDINE. Kvichko, L. A.; Tolmachev, V. N.; Konkin, V. D. (Ukrainian Scientific-Research Inst. of Metals, Kharkov). Ukr. Khim. Zh.; 36: 494-6(May 1970). (In Russian).

The extraction of Zr, Hf, Th, and Fe(III) complexes with Arsenazo I and diphenylguanidine was studied as a function of the pH of the aqueous phase and concentration of reagents. A method for the extraction–photometric determination of microgram quantities of Zr in steel without separating the base element is described. (R.V.J.)

36379 STUDIES ON THE SEPARATION OF RARE EARTHS. DETERMINATION OF THE OPTIMUM CONCENTRATION OF LIGAND ION USED IN ELECTROMIGRATION. Ohyoshi, Emiko (Kumamoto Univ., Japan). Bull. Chem. Soc. Jap.; 43: 1387-9 (May 1970).

An attempt to determine the optimum concentration of ligand ion for the separation of adjacent pairs of rare earth elements by electromigration was made using the method employed for the determination of the stability constant of complex. To examine the theory, separation of La and Ce, and Ce and Pr was carried out using α-hydroxyisobutyric acid as a complexing agent. From the results, factors necessary for the separation of all kinds of rare earth elements were discussed. (auth)

36380 ANION EXCHANGE STUDIES OF ZIRCONIUM(IV) IN MALONATE SOLUTION. Khopkar, S. M.; Yadav, A. A. (Indian Inst. of Tech., Bombay). Sci. Cult. (Calcutta); 35: 696 (Dec 1969).

A study of the use of the zirconium(IV) complex with malonic acid for the separation of Zr on the anion exchange resin Dowex 21K was made. Results show that Zr can be separated from Be, Mg, Ca, Al, alkali, and metals by a process of selective sorption. Elements such as Pb, U, Ni, Sb, Fe, and Cu that also form malonate complexes can be separated by a process of selective elution. (D.H.M.)

36381 SYNTHESIS OF THORIUM MOLYBDATE AND ITS USE FOR THE QUANTITATIVE SEPARATION OF IRON(III) FROM ZINC(II), COBALT(II), AND COPPER(II). Qureshi, Mohsia; Husain, Waqif (Aligarh Muslim Univ., India). J. Chem. Soc., A; No. 8, 1204-7(1970).

A new monofunctional amorphous cation exchanger, thorium molybdate, was synthesized under a range of conditions. The ion-exchange properties of the various products were studied, and the Th: Mo ratios determined. The fairly stable product with Th: Mo ratio 1: 2 was used successfully for the quantitative separations of Fe^{3+} from Cu^{2+}, Zn^{2+}, and Co^{2+}. (auth) (UK)

36382 STUDIES OF THE BEHAVIOR OF TRIVALENT URANIUM IN AN AQUEOUS SOLUTION. III. EXTRACTION FROM A HYDROCHLORIC ACID SOLUTION BY BIS(n-BUTYL) ORTHOPHOSPHORIC ACID AND BY BIS(2-ETHYLHEXYL) ORTHOPHOSPHORIC ACID. Sato, Akiko; Suzuki, Shin (Tohoku Univ., Sendai). Bull. Chem. Soc. Jap.; 43: 1380-2(May 1970).

The distribution of U(III) between HCl solutions and benzene solutions of bis(n-butyl) orthophosphoric acid or cyclohexane solutions of bis(2-ethylhexyl) orthophosphoric acid was investigated by using the ^{237}U as a tracer. It was found that the log-log plot of the distribution ratio vs. the concentration of dimeric

organophosphoric acids, and that of the distribution ratio vs. the hydrogen ion concentration, always show a good linearity, with a slope of 3. This indicates that the complex-forming reaction is as follows: $U^{3+} + 3(HA)_2 \rightleftharpoons U(HA_2)_3 + 3H^+$, where $(HA)_2$ represents the dimeric solvent, $(HDBP)_2$ or $HDEHP)_2$. These results are in agreement with the conclusions reached in the cases of other trivalent actinide and lanthanide elements by other investigators. (auth)

EARTH SCIENCES

Geology and Hydrology

Refer also to abstracts 36174, 36346, 36449, 36483, 36485, and 36627.

36383 (CEA-R-3965) RADIOACTIVE POLLUTION BY RADON IN VERTICAL DRILL HOLES. Bourseau, Roland; Fabre, Pierre; Zini, Edmond (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). May 1970. 16p. (In French). Dep. CFSTI (U. S. Sales Only).

Radioactive contamination by radon of exploration drill holes for uranium was examined. An evaluation was made of the very small quantities of radon involved. The changes produced in the whole gamma spectrum from the ore in situ by a radon source situated near the measuring probe were determined by simple discrimination. The experiments were carried out either in a dry environment or underwater. The quantity of radon present was defined by a coefficient expressed as a ratio varying from 1 to 3 between an ore in radioactive equilibrium and a radon source without ore. Therefore, the amount of contamination can be evaluated. These results were obtained in the laboratory and must be verified in the field. (auth) (France)

36384 (NVO-38-25) EMPLACEMENT HOLE DISPLACEMENT. Houghton, Scott B.; Cole, Charles M. (Fenix and Scisson, Inc., Mercury, Nev.). Apr 1970. Contract AT(26-1)-38. 47p. Dep. CFSTI.

Lateral displacement from true vertical occurred in rotary drilling of large diameter emplacement holes at the Nevada Test Site. Hole deviation experienced in emplacement holes drilled in the Yucca Flats area is discussed. The report reviews holes drilled in the past four years, analyzes the cause of their deviation, and discusses measures to improve straight emplacement hole drilling. (auth)

36385 (RLO-2218-1) BACKGROUND STUDY FOR POND COOLING FOR INDUSTRY. Decker, Fred W. (Oregon State Univ., Corvallis). 31 Mar 1970. Contract AT(45-1)-2218. 53p. Dep. CFSTI.

The use of lakes and slack water for the disposition of waste heat from thermal power plants was studied. A number of individuals in Europe directly involved in solving this problem for industry or in performing research bearing upon this subject were contacted. Scientists appear preoccupied with the establishment of limits to the allowable discharge of heat into streams until it becomes clear that further development of heat power generating capacity simply must include means other than surface water for disposing of the waste heat. Thus, in Switzerland and Bavaria work continues on the prescription of the limits as to how much and in what manner heat may discharge into streams. In the Netherlands already the forecast emerges of eventually more heat than the Rhine and impounded waters can handle. In France studies seek to specify limits for discharge of heat into the inland slack waters of major controlled rivers. In Britain the studies of a lake used for cooling a nuclear power plant will reveal objective data on the modifications in the lake conditions, but new construction generally assumes the use of cooling towers because of the general shortage of water available for cooling. A prominent international firm engaged in cooling-tower design points to the numerous cooling towers in Britain and throughout Europe as evidence of the choice which many new installations must make in order to avoid disadvantages of cost, location, and liability when using public waters. It appears that cooling towers have superseded other methods for heat discharge and that increasingly many new major industrial units can no longer seriously consider rivers and lakes for their heat sinks, at least from a standpoint of economic advantage to themselves. (auth)

36386 TRITIUM STUDY OF THE DYNAMICS OF THE WATERS OF LAC LEMAN (GENEVA LAKE). Hubert, Pierre; Maybeck, Michel; Olive, Philippe (Paris Univ., Thonon-les-Bains, France). Compt. Rend., Ser. D; 270: 1298-1301(9 Mar 1970). (In French).

Lac Leman can be divided into three layers of different dynamic behavior, the middle layer from 50 to 150 m playing the most important part in the water turnover. The movements of thermal convection only affect the surface layer between 0 and 50 m, whereas the waters of the deepest layer exhibit a large degree of inertia. By the use of tritium as an isotopic tracer it is possible to differentiate masses of water of identical physico-chemical composition. This isotope also offers a time scale and is therefore particularly well suited to research on the dynamic behavior of lakes. (France)

36387 DISTRIBUTION OF FALLOUT AND NATURAL GAMMA RADIONUCLIDES IN LITTER, HUMUS, AND SURFACE MINERAL SOIL LAYERS UNDER NATURAL VEGETATION IN THE GREAT SMOKY MOUNTAINS, NORTH CAROLINA-TENNESSEE. Ritchie, J. C. (Univ. of Georgia, Athens); Clebsch, E. E. C.; Rudolph, W. K. Health Phys.; 18: 479-89(May 1970).

The bulk density, pH, and weight of unincorporated organic matter were determined in soils at four sites of contrasting exposure and vegetation cover at different elevations. Total ^{137}Cs, ^{106}Ru, ^{144}Ce, and ^{40}K in the organic matter and first 11.4 cm of mineral soil were determined by gamma spectrometry from samples taken in early September 1961. Totals of these fallout nuclides ranged from 95.6 to 144.5, 81 to 137, and 88 to near 418 $\mu Ci/m^2$, respectively. The pattern of distribution of nuclides is related to precipitation, vegetation cover, and layer in the soil, with ^{137}Cs showing the most consistent pattern. (auth) (UK)

36388 DISTRIBUTION OF SLOW NEUTRONS IN HOMOGENEOUS, WATER-BEARING SANDSTONE. Starikov, V. N.; Enikeeva, F. Kh. This paper was summarized in At. Energ. (USSR); 27: 219(Sep 1969) as paper No. 338/5344. (In Russian).

The neutron distribution in water-bearing sandstone was found by a statistical-testing (Monte Carlo) method. The spatial distribution of slow neutrons, of energy 1 to 2 eV, was calculated for homogeneous sandstone with various water saturations (0.5 to 35%). A Po-Be source was used. In the energy range between the source energy and 1 to 2 eV, elastic and inelastic scattering occurred. The calculation scheme took into account all types of interactions among neutrons of a given energy and the nuclei of the material. The interaction cross sections and the angular distributions of the scattered neutrons were taken from the literature. The cross sections of all the reactions except elastic and inelastic scattering were combined into an absorption cross section. The neutron source was the origin of coordinates. Because the source was isotropic, the neutron trajectory at each step could be rotated with respect to the origin of coordinates; the scattering point was thus always on a coordinate axis. The space around the source was divided into spherical layers of 5 to 80 cm radii. The dependence of the slow neutron flux on the porosity m (water content) of sandstone of mineralogical density 2.65 g/cm^3 at various distances from the source was illustrated. The small step in the porosity (no more than 2.5%) and the rather complete account of the various physical factors implied that the dependence of the neutron distribution on the hydrogen content (water content) in homogeneous sandstone was monotonic. (auth)

36389 FISSION-TRACK DATING OF VOLCANIC GLASSES AND THE THERMAL HISTORY OF ROCKS. Storzer, D. (Max-Planck-Institut fuer Kernphysik, Heidelberg). Earth Planet. Sci. Lett.; 8: 55-60(Mar 1970).

The fission track method was applied to get information about a sample's thermal history, using Permian pitchstone glasses from South Tyrol as an example. The fission track ages obtained were lowered due to thermal annealing. They range between 61 to 186 Myr. Going from the south to the north, the ages decreased. Size studies of the fossil fission tracks revealed that the measured ages were mixed ages, composed of a thermally unaffected and a thermally affected age. The latter part of the mixed ages can be corrected. The corrected fission track ages converged to a mean age of 256 Myr. The thermally unaffected ages dated the end of the last thermal event. They ranged between 21 and 149 Myr. The measured and the corrected fission track ages as well as the thermal history of the pitchstones are discussed. The results are a typical example how to use fission tracks as geological thermometer. (auth)

36390 REFRACTION SHOOTING AT THE SITE PROJECTED FOR THE NUCLEAR POWER PLANT IN LINKOU, TAIPEI, TAIWAN. Chiang, S. C. Petrol. Geol. Taiwan; No. 6, 263-83 (1968).

A total of 13 seismic refraction profiles were made at the site for the Taiwan Power Company's nuclear power plant at Hsiafu village northwest of Linkou, Taipei, Taiwan. The T method, which employs time delay to calculate depth, was utilized to determine the thickness of the overburden and underlying bed rock as well as the wave velocity between different interfaces. Results revealed that the overburden is Holocene alluvium varying in thickness from 4 to 14 m and with a P-wave velocity of 400 m per sec. The bedrock, with velocity of 1700 m per sec is the Tananwan Formation of Pleistocene age in unconformable contact with the alluvium. No faults or fractures were found. (Geophys. Abstr.)

36391 NEW DATING TECHNIQUE USING THERMALLY STIMULATED CURRENT. Hwang, F. S. W.; Fremlin, J. H. (Univ. of Birmingham, Eng.). Archaeometry; 12: 67-71(Feb 1970).

The principle of the thermally stimulated-current (TSC) dating technique is similar to the basic principle of the thermoluminescence (TL) dating technique except that trapped electrons which are thermally released into the conduction band are collected as transient current rather than detected by light-emission. TSC is less susceptible than TL to non-uniform distribution of the grains which are responsible for luminescence in the sherd, chemiluminescence, lack of transparency of sample causing attenuation of luminescence, and black body radiation. Also, since the sample is not ground to powder form, triboluminescence can be neglected. An important feature of this TSC technique is that the method seems to be usable in the region of one to three million years. The apparatus used and the experimental technique is described. Suitable samples to test the method have been difficult to obtain but results on three basalt samples are given. (UK)

36392 THERMOLUMINESCENT DATING OF A TERRACOTTA OF THE NOK CULTURE, NIGERIA. Fagg, B. E. B. (Oxford Univ.); Fleming, S. J. Archaeometry; 12: 53-5(Feb 1970).

The fabric of the Jemaa Head was dated by using the TLD technique on a piece of baked clay fabric removed from the inside of the head. The accuracy of the measurement, due to doubts concerning the burial conditions, are discussed and the corrections applied. The estimated age is given as 2480 ± 220 years or, if the dosage from radon emanation measured for the soil is presumed to be completely lost, as 2570 ± 230 years. (UK)

36393 DETERMINATION OF GROUND-WATER AGES BY THE T-^{3}He METHOD. Tolstikhin, I. N.; Kamenskii, I. L. (Inst. of Precambrian Geology and Geochronology, Leningrad. All-Union Petroleum Geology Exploration Inst., Leningrad). Geochem. Int. (Engl. Transl.); 6: 810-11(Apr 1969).

Translated from Geokhimiya; No. 8, 1027-9(Jul-Aug 1970).

Determining the age of ground waters from their tritium contents was difficult because of the large variations in the tritium content of precipitation. Tritium decays to ^{3}He and it is suggested that the ^{3}He accumulation in the water could be used to measure the decayed tritium, so the initial tritium content can be found. Helium-3/helium-4 and He/Ne ratios could be used to correct for atmospheric He contributions, or detect He from older admixed waters. (auth)

36394 IONIUM AGES AND THE PROCESS OF FORMATION OF VOLCANIC ROCKS. Kuptsov, V. M.; Cherdyntsev, V. V.; Kuz'mina, E. A.; Sulerzhitskii, L. D. (Geological Inst., Moscow). Geochem. Int. (Engl. Transl.); 6: 671-5(Apr 1970).

Translated from Geokhimiya; No. 7, 829-34(Jul-Aug 1969).

Maximum ages of 14 minerals and of heavy fractions separated from Mt. Zmeyka trachyliparite (Kazakh Mineral Waters) and basalt from Onekotan Island (Kurile Islands) were determined by the ratios of ionium and protactinium to their parent elements and by the method proposed by Cerrai et al. (comparison of Io/Th and U/Th ratios in two minerals from the same rock). Discordant and often absurd results (negative ages or the initial Io/Th ratio) were obtained by the second method, and it was found that at least five generations of minerals with different radioisotope ratios were present in trachyliparite. Formation of volcanic rocks cannot be considered as a result of cooling of a single homogeneous melt. Critical analysis of results obtained by the first method showed that the most probable age of Mt. Zmeyka trachyliparite was 14 ± 2 thousand years, and of basalt from the Onekotan Island, 160 thousand years. (auth)

36395 THERMOLUMINESCENCE AUTHENTICITY TESTING OF SOME SIX DYNASTIES FIGURES. Fleming, S. J. (Oxford Univ.); Moss, H. M.; Joseph, A. Archaeometry; 12: 57-65(Feb 1970).

The accurate dating of pottery sherds by TLD has been the subject of much work. For authenticity testing the accuracy required need only be sufficient to distinguish between the supposed age (if authentic) and an age of less than say 100 years. The procedures developed and now used routinely, for authenticity testing are described and the application to nine Chinese "Six Dynasties" figures reported. (UK)

36396 GEOCHRONOLOGY: RECENT DEVELOPMENT IN THE ^{176}Lu/^{176}Hf DATING METHOD. Boudin, Andre; Deutsch, Sarah (Univ. Libre, Brussels). Science; 168: 1219-20(5 Jun 1970).

The application of the lutetium-176/hafnium-176 method to gram quantities of minerals containing rare earths is made possible by the development of analytical and isotope dilution techniques for microgram amounts of lutetium and hafnium. The geological redetermination of the half-life of lutetium-176 ($3.3 \pm 0.5 \times 10^{10}$ years) is in agreement with recent physical measurements. (auth)

36397 PRESSURE-VOLUME EQUATION OF STATE OF CONSOLIDATED AND FRACTURED ROCKS TO 40 kb. Stephens, D. R.; Lilley, E. M.; Louis, H. (Univ. of California, Livermore). Int. J. Rock Mech. Mining Sci.; 7: 257-96(1970).

A rapid and accurate method to obtain pressure-volume data to 40 kb at 25°C for rocks is presented. Typical data for both consolidated and artificially fractured materials are included. The pressure-volume curves so obtained can be related to the initial porosity of the consolidated rock and to porosity induced by fracturing the test samples. The qualitative features of the pressure-volume curves are consistent with a model of the effect of porosity on compressibility. The experimental results may also be related to the in situ elastic properties of the rock. These pressure-volume data, together with other mechanical properties, are used for numerical calculations of the effects of explosions in rock. Several nuclear explosions and high-explosive detonations in the Plowshare Program of the AEC have been successfully calculated using this type data. (auth)

36398 NONINSTRUMENTAL FACTORS AFFECTING MEASUREMENT OF STATIC WATER LEVELS IN DEEPLY BURIED AQUIFERS AND AQUITARDS, NEVADA TEST SITE. Winograd, Isaac J. Ground Water; 8: 10p(Mar-Apr 1970).

Accurate measurement of static water levels in wells tapping deeply buried aquifers and aquitards at the Nevada Test Site requires evaluation of and correction for several factors exclusive of instrumentation. Both the drilling method used and the depth of the hole at the time of measurement significantly affect determination of the static water level for the aquitards, and frequently these factors preclude head determination in an economically justifiable time. Density of fluid in the drill stem and hole deviation affect the determination of accurate static water levels for the aquifers. In the principal aquifers, in which hydraulic gradients are as low as 0.5 foot per mile, direct measurement of depth to water is preferable to pressure-gage measurements at the aquifer face. Case histories and graphs are presented to illustrate the magnitude of errors that can result when these factors are disregarded. (auth)

36399 STRATIGRAPHY AND GEOLOGIC TIME. Harbaugh, John W. Brown Foundations of Earth Science Series. Dubuque, Iowa; Wm. C. Brown Company Publishers (1968). 119p. $1.95.

Six chapters are included; a separate abstract was prepared for one. The remaining five chapters contain information on geologic time scale; stratigraphic correlation; unconformities; thickness maps and paleogeologic maps; and sedimentary facies. (J.C.W.)

For an abstract of one chapter see: 36400.

36400 RADIOMETRIC AGE DATING. pp 76-110 of Stratigraphy and Geologic Time. /Harbaugh, John W. Dubuque, Iowa; Wm. C. Brown Co. Publishers (1968).

Radioactive nuclides decay at specific rates; a summary is given of how the determination of geologic time is made possible by their use. Discussions are presented on nature of atoms and radioactivity; probability and radioactivity; mathematical statement of law of growth and decay; radioactive nuclides; decay clocks and especially carbon-14 decay clocks; accumulation clocks and especially uranium-lead and thorium-lead methods; potassium-argon and rubidium-strontium methods; and quantifying the geologic time scale. (J.C.W.)

36401 PHASE TRANSFORMATIONS AND THE EARTH'S INTERIOR. UPPER MANTLE PROJECT SCIENTIFIC REPORT NO. 26. Proceedings of a Symposium Held in Canberra, Australia, 6-10 January 1969. Ringwood, A. E.; Green, D. H. (eds.). Phys. Earth Planet. Interiors; 3: 1-518(1970). (CONF-690122).

Fifty-eight papers were presented at the conference. A separate abstract was prepared for one. Fifty-seven were not within the scope of NSA. (L.C.L.)

For an abstract of one paper see: 36431.

36402 BARIUM ISOTOPE METHOD FOR MEASURING CATION-EXCHANGE CAPACITY OF SOILS AND CLAYS. Bache, B. W. (Macaulay Inst. for Soil Research, Aberdeen, Scotland). J. Sci. Food Agr.; 21: 169-71(Apr 1970).

Cation-exchange capacity has been measured by isotopic exchange of ^{133}Ba with Ba^{2+}-saturated soils and clays in 2.5×10^{-3} M-$BaCl_2$ suspensions. The rate of isotopic dilution, the efficiency of displacement of soil cations by Ba^{2+}, and the precision of the method are critically assessed. The method is reliable and convenient, and can be used with both buffered systems. (auth) (UK)

36403 ISOTOPIC COMPOSITION OF URANIUM (^{234}U, ^{238}U) IN WATERS AND BOTTOM SEDIMENTS OF THE BALKHASH LAKE AND THE TIME OF THE BASIN EXISTENCE. Chalov, P. I.; Svetlichnaya, N. A.; Tuzova, T. V. (Inst. of Physics and Mathematics, Frunze, USSR). Geokhimiya; No. 7, 848-54(Jul 1970). (In Russian).

The results of $^{234}U/^{238}U$ ratio studies in waters and bottom sediments of the Balkhash Lake are reported. On the basis of the data received according to ^{234}U decay, the absolute age of the Balkhash Lake (37 ± 7 thousand years) was established. (auth)

36404 RADIOACTIVITY OF A CALIFORNIA TERRACE SOIL. Hansen, Richard O. (Univ. of California, Davis). Soil Sci.; 110: 31-6(Jul 1970).

The radioactivity per unit area and depth of a California terrace soil was calculated. This is of use when assaying background activities or surveying radioactivities with detectors above the soil surface or in airplanes. When freed from minerals by weathering, uranium is leached more rapidly than is thorium, although thorium also shows evidence of movement. The degree of loss of uranium versus ^{230}Th is calculated and knowing the age of the sedimentary deposit, the rate of loss of uranium was estimated. Determinations of thorium by two independent means (alpha and gamma spectrometry), show reasonable agreement. ^{226}Ra activities were close to those of ^{230}Th as might be expected. (auth)

36405 URANIUM DISTRIBUTION IN SEDIMENTARY ROCKS IN THE WESTERN PART OF THE AMU DARYA PETROLEUM BASIN. Alekseev, F. A.; Gottikh, R. P.; Vorob'eva, V. Ya.; Murav'eva, L. V. (All-Union Nuclear Geophysics and Geochemistry Research Inst., Moscow). Geochem. Int. (Engl. Transl.); 6: 963-70(Jun 1970).

Translated from Geokhimiya: No. 10, 1238-47(1969).

Distribution of uranium in some Mesozoic sedimentary rocks of west Uzbekistan was related to conditions of sedimentation and diagenesis. Higher than average uranium contents occurred in coastal shallow-water facies; uranium contents gradually decreased in facies of intermediate depths but then increased anew towards the open sea. Highest values of uranium were observed for sandstones in coastal shallow-water facies and for clays in the open-sea facies. Evidence from fission track studies demonstrated a strong correlation between radioelement content and content of organic carbon. (auth)

36406 RADIOISOTOPES IN WATERS OF NEOVOLCANIC REGIONS OF THE CAUCASUS. Kuptsov, V. M.; Cherdyntsev, V. V.; Zverev, V. L. (Geological Inst., Moscow). Geochem. Int. (Engl. Transl.); 6: 919-22(Jun 1970).

Translated from Geokhimiya: No. 9, 1153-5(1969).

Concentrations and ratios of ^{238}U, ^{234}U, ^{232}Th, ^{228}Th, ^{226}Ra, and Rn were measured in waters from the Caucasus where no volcanic activity had occurred for several thousand years. Low radium concentration and Ra/U ratios suggested radium loss from the waters; high U/Rn ratios were attributed to lower diffusion rates from cold extrusives than from the heated rocks of areas of active volcanism. (auth)

Meteorology

Refer also to abstracts 36208, 36445, 36475, 37291, 37369, and 37385.

36407 (AD-703856) FALLOUT MIGRATION FROM A SLOPED ROOF. Maloney, Joseph C.; Miller, Andrew S. (Ballistic Research Labs., Aberdeen Proving Ground, Md.). Feb 1970. 26p. (BRL-1476). CFSTI.

The objective of the overall project was to develop and test radiological countermeasures that are applicable to post-nuclear attack recovery operations. An exploratory experiment was conducted on the possible effectiveness of passive roof decontamination, by weather induced migration, in reducing the potential exposure rate in the basement shelter area of a small dwelling having a sloped roof. Contrary to expectations that migration would cause dose rates to decrease in basement shelter areas, the actual migration of fallout particles from a sloped roof may cause such dose rates to either increase or decrease with time. The presence of gutters can effect a dose increase during early time. The same effect may be expected in some, but not all shelter space if the fallout fell in a line under the roof eaves. Even mild weather conditions can have significant effect on the movement of fallout particles on a sloped roof. (auth) (USGRDR)

36408 (HASL-227) FALLOUT PROGRAM QUARTERLY SUMMARY REPORT, MARCH 1, 1970-JUNE 1, 1970. Hardy, Edward P. Jr. (New York Operations Office (AEC), N. Y. Health and Safety Lab.). 1 Jul 1970. 190p. Dep. CFSTI.

Current data from the HASL Fallout Program, The Institute of Radiation Hygiene in Prague, Czechoslovakia, The Air Resources Laboratories of the Environmental Science Services Administration, The Woods Hole Oceanographic Institute, The Radiological Physics Division at Argonne National Laboratory, and the EURATOM Joint Nuclear Research Centre at Ispra, Italy are presented. The initial section consists of interpretive reports and notes covering the following topics: ^{90}Sr in human bone from Czechoslovakia in 1969, contamination of one of the samplers used in The High Altitude Balloon Program, levels of plutonium-239 in marine organisms and sediments, fallout of SNAP-9A debris, stratospheric inventories of ^{90}Sr, ^{95}Zr and ^{239}Pu, global deposition of ^{90}Sr, and ^{85}Sr fallout. Subsequent sections include tabulations of radionuclide levels in stratospheric air, surface air, fallout, milk, other diet components, tap water, and human bone. A bibliography of recent publications related to radionuclide studies is also presented. (auth)

36409 (HASL-227(App.)) APPENDIX TO FALLOUT PROGRAM QUARTERLY SUMMARY REPORT, MARCH 1, 1970-JUNE 1, 1970. (New York Operations Office (AEC), N. Y. Health and Safety Lab.). 1 Jul 1970, 397p. Dep. CFSTI.

Monthly data acquired in the Health and Safety Fallout Monitoring Program are tabulated and include: the ^{89}Sr and ^{90}Sr content in atmospheric precipitation deposited at 104 world monitoring sites during 1957 to 1970; the ^{90}Sr deposition, precipitation and concentrations at Atlantic Ocean weather stations from June 1965 to Jan. 1970; and the ^{238}Pu and ^{239}Pu content in precipitation at 8 worldwide sites during 1966 to 1970. Monthly data on the radioisotopes content in surface air at approximately 20 stations in the western hemisphere are given for the following specific isotopes and time periods: ^{54}Mn during 1963 to 1970; ^{55}Fe during 1964 to 1969; ^{89}Sr and ^{90}Sr during 1963 to 1970; ^{95}Zr during 1963 to 1969; ^{109}Cd during 1964 to 1968; ^{140}Ba during 1965; ^{141}Ce during 1965 to 1969; ^{144}Ce during 1963 to 1970; ^{238}Pu and ^{239}Pu during 1965 to 1970; and stable lead during 1966 to 1970. Monthly data on the ^{90}Sr/calcium ratio in whole milk in New York City and in powdered milk from New York State during June 1954 to April 1970, and the ^{90}Sr content during 1954 to 1970 and $^{137}Cs/^{90}Sr$ ratio during 1965 to 1970 in New York City tap water are presented. (L.C.L.)

36410 (JUL-603-ST, pp 227-42) SPREAD OF RADIOACTIVE MATERIAL IN THE ATMOSPHERE. INSTRUMENTATION FOR DIFFUSION EXPERIMENTS WITH RADIOACTIVELY LABELED AIR VANES: EQUIPMENT FOR AEROSOL RELEASE, RADIO-CONTROLLED SAMPLING STATIONS. Vogt, K. J.; Carlebach, J.; Nordsieck, H. (Kernforschungsanlage, Juelich (West Germany). Zentralabteilung Strahlenschutz). (In German).

A two-part program for studying the pattern of radioactive environmental contamination by a reactor is outlined. First, the lower atmosphere is studied for convection and turbulence with a multicomponent vector vane. Second, radioactive material is released at various heights from a tower and surface contamination is measured by 44 stations located at various distances downwind from the point of release. The measuring stations are controlled by a centralized short wave transmitter. Copper-64 is suggested for use in the experiments. A diagram depicts the apparatus in which ^{64}Cu is to be handled and brought into solution. This solution is then released into the air by an aerosol generator. Both the structure and intended location of the measuring stations are described and depicted. The short wave transmitter and receivers are discussed and shown in block diagrams. Actual experimentation is expected to begin in spring 1969. (H.B.G.)

36411 (JUL-603-ST, pp 243-53) SPREAD OF RADIOACTIVE MATERIAL IN THE ATMOSPHERE: STUDY OF AIR CONVECTION WITH A VECTOR VANE. Polster, G. (Kernforschungsanlage, Juelich (West Germany). Zentralabteilung Strahlenschutz). (In German).

With a vector vane Mark II at 50 m above ground, wind velocities were measured in the horizontal as well as in the vertical direction. Both hourly changes during a given day and monthly changes throughout one year were recorded. The findings are presented in the form of tables and diagrams. It was concluded that dispersion of radioactive material in the air depends not only on wind velocity but also on temperature gradient and the formation of inversion layers. (H.B.G.)

36412 (JUL-603-ST, pp 254-9) SPREAD OF RADIOACTIVE MATERIAL IN THE ATMOSPHERE: VERTICAL DISTRIBUTION MEASUREMENTS OF NATURAL RADIOACTIVITY IN AIR FROM A METEOROLOGICAL TOWER. Nordsieck, H.; Polster, G.; Vogt, K. J. (Kernforschungsanlage, Juelich (West Germany). Zentralabteilung Strahlenschutz). (In German).

To study the exchange and distribution of radioactivity in the atmosphere, air samples were drawn through filters at various

altitudes from one m to 120 m above ground. The filters were then counted and analyzed for radon and its daughters. On clear days, radioactivity of the air decreases strikingly with altitude and at night because of the formation of an inversion layer. After sunrise, the inversion layer dissolves and thermal convection leads to an even distribution of radioactivity independent of altitude. On cloudy days, the radioactivity is evenly distributed throughout the air irrespective of the time of day. (H.B.G.)

36413 (SC-M-70-144) WIND DATA FOR THE ALBUQUERQUE AREA. Olson, Clifford A.; Hall, Mary H.; Plagge, Herbert J. (comps.) (Sandia Labs., Albuquerque, N. Mex.). May 1970. 464p. Dep. CFSTI.

Daily wind direction and speed data are presented for low-altitude levels in the Albuquerque area for 1961 to 1970. (J.R.D.)

36414 CONCENTRATION OF RADON UNDER ATMOSPHERIC PRESSURE. Fiuza, A.; Barreira, F. (Comissao de Estudos de Energia Nuclear, Lisbon). Rev. Port. Quim. (Lisbon); 10: 157-60(1968). (In Portuguese).

The atmospheric radon concentration has been correlated with the atmospheric pressure. The correlation coefficient is very low and the result supports the lack of relation between the two quantities. The conclusion agrees with the generally accepted ideas on the origin and diffusion of atmospheric radon. (auth)

36415 SOVIET STUDIES IN THE NUCLEAR METEOROLOGY. Karol, I. L.; Malakhov, S. G.; Makhon'ko, K. P. Izv. Akad. Nauk SSSR, Fiz. Atmos. Okeana; 6: 352-65(Apr 1970). (In Russian).

A brief survey is presented of the most important results obtained in the USSR during the last decade in studies on the atmospheric natural radioactivity, radioactive aerosol size and composition and regularities of their transport in the atmosphere, self-scavenging of the atmosphere from radioactive contaminants, and use of radioactive nuclides as atmospheric tracers. (auth)

36416 SOME PROPERTIES OF IONIZING RADIATIONS AND RADIOACTIVE IONS IN THE NATURAL ENVIRONMENT. Kawano, Minoru; Ikebe, Yukimasa; Nakashima, Yoshiyuki; Nakayama, Takeyoshi; Shimo, Michikuni (Nagoya Univ., Japan). Mem. Fac. Eng., Nagoya Univ.; 21: 250-72(Nov 1969).

Results are given of measurements of ionization intensities due to the beta and gamma radiations near the ground from 1963 through 1969. The influence of fallout radioactivity deposited on the ground surface was studied from the view point of atmospheric ionization. The beta radiation from the fallout radioactive nuclides deposited on the ground surface decreased greatly during the last 6 years, and recently, a newly designed ionization chamber made of plastic plates was used for measuring the beta radiation. The ionization intensity due to the gamma radiation did not change as much as that due to the beta radiation during the same period. A spectroscopic method with NaI scintillation counter was adopted for obtaining some detailed informations on the terrestrial gamma radiation. In January 1967, sudden increases of the ionization intensities due to the beta and gamma radiations from the fallout radioactivity caused by a nuclear explosion test were measured. The physical properties of RaA ion are reviewed. To clarify the interaction between RaA ions and condensation nuclei, simultaneous measurements of the concentrations of RaA ions (n_A), radon-222, condensation nuclei (Z) and the diffusion coefficient of condensation nuclei (D) were carried out. It was found that the correlation among them may be well expressed by the simple formula: $q_A = \beta_A n_A Z$. The correlation between β_A and D (or radius of nuclei) was also obtained. The effective attachment coefficient of RaA ions was compared with that of small ordinary ions, and it was presumed that about 25 percent of RaA atoms formed on the decay of radon-222 seem to have some charge, and the remaining 75 percent have no charge. (NSA of Japan)

36417 CALCULATION OF PLANETARY DISTRIBUTIONS OF RADON AND ITS LONG-LIVED DAUGHTER CONCENTRATIONS IN THE TROPOSPHERE AND LOWER STRATOSPHERE. Karol, I. L. (Inst. of Experimental Meteorology, Moscow). Tellus; 22: 219-27(1970).

The boundary value problem for the differential equation for mean zonally averaged tracer concentrations in the meridional plane up to 25 km level and from pole to pole was introduced and connected with a model of tracer transport processes in the atmosphere on a global scale. The coefficients of this equation are determined from climatic data on the mean meridional circulation and macroturbulent diffusion. The finite difference analogue of this problem was solved numerically by the method of matrix factorization, and the annual mean zonally averaged concentration distributions for ^{222}Rn, ^{210}Pb, and ^{210}Po were obtained for several variants of parameters. The results of the calculation were compared with the published data of isotope concentration measurements in the free atmosphere, and the global intensity of macroturbulent diffusion is estimated. The calculated isotope content in the troposphere and stratosphere of the northern and southern hemispheres and their rates of transport across the equator and through the tropopause are briefly outlined. (auth) (Sweden)

36418 COMPUTER CINEMATOGRAPHY FOR PORTRAYAL OF LARGE SCALE FALLOUT. Blifford, Irving H. Jr.; Burgmeier, James W. (National Center for Atmospheric Research, Boulder, Colo.). Atmos. Environ.; 4: 187-97(Mar 1970).

From the data obtained by the United States Public Health Service Radiation Surveillance Network, a method was devised for using the Control Data Corporation 6600 computer with dd80 microfilm output to portray cinematographically, time and space variations in the concentrations of fission products in surface air. In addition it was possible to show the simultaneous variations of meteorological parameters such as the 500 mb pressure surface. Other information relating to frequency and location of testing and concentration level is also presented directly on the film. This non-mathematical use of the computer appears to have considerable promise for the analysis of other large collections of geophysical data. (auth) (UK)

36419 SPECIFIC β ACTIVITY IN THE LOWER ATMOSPHERE. Facetti, J. F.; Marin, M.; Caggiano, M. T. Rev. Soc. Cient. Paraguay; 9: No. 1-2, 1-4(1968). (In Spanish).

The specific β activity of the atmosphere of Asunción is reported. Product nuclei of ^{222}Rn decay chain are the main contaminants. (auth)

36420 DATA. SECTION IV. OTHER DATA. Radiol. Health Data Rep.; 11: 261-75(May 1970).

Data from routine samplings of biological materials and other media are reported. Measurements made during April through June 1969 of the ^{90}Sr content in human bones from throughout the U. S. are described and the results tabulated. Environmental monitoring data taken during Jan. to July, 1969 at the Oak Ridge Area in Tennessee and the Savannah River Plant area in S. C. are presented. Nuclear detonations which occurred in the U. S. during April 1970 are reported. (L.C.L.)

36421 DATA. SECTION III. AIR AND DEPOSITION. Radiol. Health Data Rep.; 11: 253-60(May 1970).

Measurements of gross β-activity in surface air and precipitation at 73 stations in the U.S.A. and 24 stations in Canada, and in surface air only at 12 stations in South America for Jan. 1970 are presented. Measurements of gross β-activity in surface air at 16 stations in Mexico during Nov. 1969 are reported. (L.C.L.)

36422 DEVELOPMENT OF A METHOD FOR MEASUREMENT OF NATURAL RADIOACTIVITY. Dalu, G. Ass. Geofis. Ital., Atti Conv. Annu.; 16: 211-29(May 1967). (In Italian).

From 16th Annual Conference of Italian Geophysical Society, Naples, Italy. See CONF-670532.

A method was developed for determining the radon concentration from the beta activities measured on filters. Such a method was applied to a set of data taken at Vigna di Valle, on which a statistical study was made. The hypothesis of the radioactive equilibrium and the limits within which it may be considered valid are also discussed. (auth)

Mineralogy and Exploration

Refer also to abstract 36571.

36423 (AEC-tr-7153) BRIEF NOTES ON THE GEOLOGY OF URANIUM-BEARING DEPOSITS. Gangloff, A. (Commissariat a l'Energie Atomique, Paris (France)). Translation of French report. 28p. Dep. CFSTI.

The geologic characteristics of vein or lode deposits bearing uranium, and uranium deposits found in sedimentary rock formations in France, and of uranium bearing sedimentary deposits in French West Africa are discussed. Most of these deposits have already been surveyed. (L.C.L.)

36424 (RME-4110) SELECTED BIBLIOGRAPHY ON RADIOACTIVE OCCURRENCES IN THE UNITED STATES. Krusiewski, S. Victoria (Division of Raw Materials (AEC), Washington, D. C.). May 1970. 136p. GPO $1.25.

A compilation of references selected by evaluation of their usefulness is presented. The majority of the publications were issued in the period 1950 to early 1970. A few items published prior to 1950 are also included. (J.R.D.)

36425 URANIUM DISTRIBUTION IN ROCKS THROUGH OBSERVATION OF FISSION FRAGMENT TRACKS. Sircana, Silvia;

Gioria, Giorgio (CNEN, Rome). Com. Naz. Energ. Nucl., Notiz., 15: No. 8-9, 73-82(Aug.-Sept. 1969). (In Italian).

A method for the determination of uranium distribution in rocks by observation of fission fragment tracks in foils of muscovite mica, ordinary glass, and laminated plastic is described. The crushed and homogenized samples are placed in Plexiglas containers and covered with a foil of one of the detectors. The sample is irradiated together with a standard. The foil is treated with a solution of NaOH in order to leach out the fission fragment tracks. Typical results are given. The application of the method to the distribution of U in rocks is discussed. (J.S.R.)

36426 THE SIGNIFICANCE OF URANIUM IN QUARTZITE IN THE BEAVERLODGE AREA, SASKATCHEWAN. Tremblay, L. P. (Geological Survey of Canada, Ottawa). Can. J. Earth Sci.; 7: 280-305(Apr 1970).

Quantitative spectrographic analyses for Cr, V, Cu, Ni, and Co of 219 specimens of the country rocks from the Beaverlodge area, Saskatchewan, and chemical analyses for U of 68 of those rock specimens and for Th of 38 of them showed that positive relationships existed between the above elements and uranium in quartzite, and that quartzite may be the principal source of uranium in the uranium deposits. (auth) (Canada)

36427 URANIUM EXPLORATION USING RADON IN SOILS. Dyck, W. Can. Mining J.; 90: 45-9(Aug 1969).

Highlights of tests carried out during the 1968 field season to determine the applicability of the radon method for detailed prospecting for U are given. Where the overburden is one to two feet thick, on-site radon and thoron determinations in soil emanations in the Gatineau hills outlined radioactive pegmatites more clearly than did x-ray tests. In general the radon method outlined radioactive sources more clearly than did the Geiger counter. On-site radon-thoron emanations were determined with a portable counter using ZnS (silver activated) cell modified in such a way as to permit the flow of soil gas through it. These gases were obtained from one to two feet deep holes punched into the soil with a needle bar. (F.S.A.)

36428 RADIUM GEOCHEMISTRY APPLIED TO PROSPECTING FOR URANIUM. Morse, R. H. (Queen's Univ., Kingston, Ont.). Can. Mining J.; 90: 75-6(May 1969).

A rapid method for the relative determination of ^{226}Ra in sediments was developed and was applied to prospecting for uranium. The method discriminates against radiation from thorium, potassium, and other sources. (auth) (Canada)

36429 WORLD URANIUM PICTURE. Nininger, Robert D. (Atomic Energy Commission, Washington, D. C.). Nucl. News; 13: No. 7, 51-8(Jul 1970).

The quantity and location of present world supplies of uranium reserves, the prospects for future uranium discoveries, and the uranium requirements for nuclear power production to the year 2000 are discussed. (L.C.L.)

36430 THE USE OF GENERAL GEOPHYSICAL METHODS IN SEARCHING FOR URANIUM MINERALIZATION AT DEPTH IN SUBVOLCANIC ROCKS. Kashpirov, S. N.; Konovalov, I. M.; Luchin, I. A. This paper was summarized in At. Energ. (USSR); 27: 52-3(Jul 1969) as paper No. 320/5206. (In Russian).

The region which was investigated is situated in the northern part of a large volcano-tectonic depression, filled with a thick series of red-colored volcanogenic sedimentary rocks of Lower and Middle Devonian age. Uranium showings and deposits tend to occur spatially in the marginal part of this structure and are associated with subvolcanic felsite-porphyry intrusives, in the contact regions of which explosive breccias are developed. The processes of gaseous and hydrothermal activity are shown most strongly where explosive breccias have developed. They caused strong metamorphism of the breccias and their surrounding rocks, as a result of which metasomatic formations of zonal type arose. The internal parts of the metasomatic zone are composed of berezite surrounding uranium mineralization. Due to the berezitization process the rocks became more porous, the magnetic minerals were dispersed and they were replaced by pyrite. In turn, the increase in porosity led to a decrease in rock density; the dispersion of magnetic minerals led to a decrease in magnetic susceptibility; and the increase in porosity and pyrite concentration led to an increase in the polarizability of the rocks. The physical properties of the berezitized rocks that have been enumerated enable gravimetric, magnetic, and induced polarization survey methods to be used to isolate berezitized zones. The development of these zones is characterized by depressions in the gravitational and magnetic fields, as well as by anomalous increases in induced polarization. The results of areal investigations of the physical properties of the rocks were also used in the mapping of berezitized rocks. In the region under description berezitization zones were distinguished in areas of spatial coincidence of reduced rock density and magnetic susceptibility values (from investigations of the physical properties of rock samples taken on a 50 × 20 m grid) coinciding with relatively negative local gravitational anomalies (obtained from the mean of a Bouguer reduction with a radius of 500 m). It has been established that, within the ore field, deep faults of near E-W orientation are distinguished by axial lines of local negative gravitational anomalies; and deep faults with close N-S trends, coinciding spatially with belts of diabase- and diorite-porphyry dykes, are traced with axial lines of local positive gravitational anomalies. The results of a detailed geological survey of the surface and of underground workings in the areas investigated have confirmed the validity of this interpretation of the geophysical data. The total interpretation of all the geological and geophysical information throughout the ore field has enabled the basic patterns of its structure to be recognized, particularly the enhancement of berezitization intensity along E-W faults, as well as the presence of a large subvolcanic acid intrusive in the eastern side of the ore field, which is favorable for the occurrence of concealed uranium mineralization. (auth)

36431 GEOCHEMICAL EVIDENCE FOR THE ORIGIN OF SOME ULTRAMAFIC INCLUSIONS FROM VICTORIAN BASANITES. Kleeman, J. D.; Cooper, J. A. (Australian National Univ., Canberra). Phys. Earth Planet. Interiors; 3: 302-8(1970).

From Physics of the Earth and Planetary Interiors Conference, Canberra, Australia. See CONF-690122.

The ultramafic inclusions occurring in some undersaturated Victorian basanites are shown to be accidental xenoliths. U, Th, and K abundances and lead isotope measurements in inclusions and hosts, and uranium distribution studies in the phases of the inclusions all indicate that there is no genetic relationship between the ultramafics and the host basanites. The xenoliths are thought to be fragments of an inhomogeneous upper mantle of peridotitic composition. The lead isotope date on the lherzolites are consistent with a two-stage differentiation process from a primeval source, and the uranium concentration (mean 0.3 ppM) in the primary clinopyroxene suggests that this mineral may have this uranium abundance in a peridotitic upper mantle. (auth)

36432 URANIUM. Gourlay, A. J. (Bureau of Mineral Resources, Canberra, Australia). Aust. Miner. Ind.; 261-5(1968).

By the end of June 1969, over 30 companies were either engaged or about to commence uranium exploration in Australia, and as a result of this increased activity, resources were increased by over 10,000 short tons of uranium oxide (including possible reserves). Details of new uranium mineralization discoveries at Mount Painter, Westmoreland, and the Durack Range are given and there is a short discussion on prices and overseas production. (Australia)

36433 MONAZITE. Ward, J. (Bureau of Mineral Resources, Canberra, Australia). Aust. Miner. Ind.; 169-72(1968).

Domestic production for 1968 in Australia was 3044 tons of saleable concentrates. Early in 1969 output rate was over 4000 tons. Production and export figures for 1965 through 1968 are detailed and price trends and overseas production are briefly considered. (Australia)

36434 DEVELOPMENTS IN CANADIAN URANIUM MILLING PRACTICE. Lendrum, F. C. J. Metals; 22: No. 7, 52-6(Jul 1970).

The developments in the milling of uranium ores in Canada are reviewed. The paper includes a historical review of the milling of uranium ores from the early gravity plants to bacterial leaching. An extensive bibliography is appended. (auth)

Oceanography

36435 (NYO-2174-113) GENERAL SUMMARY OF PROGRESS, 1969-1970. (Woods Hole Oceanographic Institution, Mass.). Contract AT(30-1)-2174. 29p. Dep. CFSTI.

Measurements and interpretation of radiochemical blank samples were conducted. The ^{90}Sr content in Atlantic Ocean surface water during 1967 to 1970 was determined. The variation of ^{90}Sr concentration with ocean depth in the Atlantic Ocean during 1968 and in the Atlantic Ocean and Mediterranean Sea in 1969 was investigated. The ^{137}Cs, ^{239}Pu, and ^{90}Sr concentration at depths to 4100 m were measured in the Atlantic Ocean in Dec. 1968. Samples of deep ocean-dredged sediments were analyzed for radioisotopes content. The possible use of stable silver as an oceanographic tracer was investigated using data from the seeding of a 1969 hurricane with silver iodide. Some developments in oceanographic equipment are mentioned. (L.C.L.)

Seismology

Refer also to abstract 36443.

36436 (AD-702162) THEORETICAL STUDY OF THE GENERATION OF INFRASONIC WAVES IN THE ATMOSPHERE. Final Report, November 27, 1967–December 27, 1969. Knabe, Walter E. (Mount Auburn Research Associates, Inc., Cambridge, Mass.). Contract F19628-68-C-0176. 105p. (AFCRL-70-51). CFSTI.

The generation of acoustic and internal gravity waves in the earth's atmosphere by nuclear detonations is considered. Attention is given to a general statement of the problem and to the assessment of the importance of various generation mechanisms in the flows produced by nuclear explosions. From the significant source mechanisms, the corresponding wave emissions are estimated with reference to nuclear detonation outputs. (auth) (USGRDR)

36437 (NVO-1163-205(Vol.1)) EFFECTS OF LOCAL GEOLOGY ON THE AMPLITUDES OF SEISMIC WAVES. VOLUME I. Murphy, J. R.; Weaver, N. L.; Lamers, G. B. (Environmental Research Corp., Alexandria, Va.). Jun 1970. Contract AT-(29-2)-1163. 111p. Dep. CFSTI.

A comprehensive examination of the amplification of ground motion by near-surface site geology from both the analytical and experimental viewpoints is presented. The mathematical models available to describe amplification are presented and their limitations indicated. The geology of a number of Nevada Test Site seismic recording sites is described in detail and the quality of the available physical property data is assessed. A useable experimental amplification factor is defined in such a way that it is meaningful in terms of the available mathematical models. Experimental amplification factors are obtained for a wide variety of site geologies, ground motion intensities and epicentral distances. The observations are compared with the output of the various analytical models and the validated models are subjected to a thorough parameter study. The major conclusions are that extrapolations from weak motion measurements are valid in some applications, and that the analytic models are generally adequate for the description of the trend of the observed amplifications for the site geologies investigated. (auth)

36438 (NVO-1163-205(Vol.2)) EFFECTS OF LOCAL GEOLOGY ON THE AMPLITUDES OF SEISMIC WAVES. VOLUME II. Murphy, J. R.; Weaver, N. L.; Lamers, G. B. (Environmental Research Corp., Alexandria, Va.). Jun 1970. 149p. Dep. CFSTI.

An experimental seismic wave amplification factor is defined, and a large number of examples of amplifications observed at the Nevada Test Site for a wide range of geologic environments and ground motion intensities are presented. (L.C.L.)

36439 (ORNL-4582) SEISMIC HISTORY AND SEISMICITY OF THE SOUTHEASTERN REGION OF THE UNITED STATES. McClain, W. C.; Myers, O. H. (Oak Ridge National Lab., Tenn.). Jun 1970. Contract W-7405-eng-26. 46p. Dep. CFSTI.

A complete seismic history of the southeast region of the United States was compiled for possible use in the evaluation of the seismic hazard at proposed nuclear installation sites. Examination of the seismicity of the area, based on this history, indicated that the highest seismic risk existed in two small areas around New Madrid, Missouri, and Charleston, South Carolina, but that the general level of seismicity in the southeast region was about two orders of magnitude less than in California. Various types of special seismic histories for smaller areas of the southeast region are available for evaluations of particular sites. (auth)

36440 SEISMIC MAGNITUDES OF HIGH-YIELD UNDERGROUND EXPLOSIONS. Basham, P. W. (Dominion Observatory, Ottawa). Can. J. Earth Sci.; 7: 531-4(Apr 1970).

The seismic magnitude of the October 2, 1969 high-yield underground explosion (Milrow) in the Aleutian Islands, when compared with the magnitude of the smaller 1965 Long Shot explosion, suggested that in the yield range near 1 megaton the yield exponent in the amplitude–yield relationship was significantly less than the value of unity which applies for yields less than 100 kilotons. The lower exponent was shown to apply equally well to Nevada Test Site high–yield explosions. A general Aleutian site effect was observed to produce seismic magnitudes for Aleutian explosions that were about m0.3 larger than those of similar-yield explosions at the Nevada Test Site. (auth) (Canada)

ENGINEERING

Nuclear Explosions

Refer also to abstracts 36357, 36457, 36460, 36485, 37003, and 38061.

36441 (CONF-700521-1) CAVITY MINING AT THE NEVADA TEST SITE. Murphy, Sheldon D. (Fenix and Scisson, Inc., Mercury, Nev.). [1969]. 20p. Dep. CFSTI.

From AIME Pacific Southwest Mineral Industry Conference, San Francisco, Calif.

The equipment and procedures used to construct deep waterproof cavities in which underground nuclear explosions are detonated are described. These cavities are usually mined from 48 in. ID cased shafts at depths from 2000 to 4500 ft below ground level. (L.C.L.)

36442 (NCG-TR-18) A SIMPLE TECHNIQUE TO DETERMINE THE SIZE DISTRIBUTION OF CRATER FALLBACK AND EJECTA. Anderson II, B. D. (Army Engineer Nuclear Cratering Group, Livermore, Calif.). Mar 1970. 43p. Dep. CFSTI.

Particle size distributions of fallback and ejecta were determined principally by mechanical sieving and weighing. However, as the size of nuclear craters produced in the experimental program increased, it became increasingly more expensive to continue this procedure, particularly since the reliability of the data was proportional to the fraction of total available material investigated. An alternate technique to sieving and weighing involved the selection and measurement of particles lying beneath points along a selected line of traverse. A pebble count technique originated by Wolman (1954) was modified and given theoretical justification (Delesse Relation) for generating a cumulative curve interpretable as a size-weight distribution. Data gathered to date indicated the results obtained were comparable to sieving and weighing the same material. Application of the technique to the Danny Boy, Cabriolet, Buggy and Pre-Schooner Alpha, Bravo, and Charlie Crater ejecta indicates the method can be successfully applied to both nuclear and chemical explosive crater fallback and ejecta. (auth)

36443 (PNE-522) A CONTRIBUTION TO THE ANALYSIS OF SEISMIC DATA FROM CRATERING AND CONTAINED EVENTS. Schooner Event. Hays, W. W.; Mueller, R. A.; Spiker, C. T. Jr. (Environmental Research Corp., Alexandria, Va.). 18 Jul 1969. Contract AT(29-2)-1163. 108p. Dep. CFSTI.

Schooner, a nuclear cratering detonation, provides experimental verification of scaling theory which shows that so far as generation of seismic motions is concerned, a cratering detonation can be considered as a contained detonation buried at a relatively shallow depth. Comparison of the seismic data observed from Schooner and other cratering and contained detonations at Nevada Test Site shows several basic differences in the characteristics of the ground motion. The shallow depth of burial of the cratering detonation causes the seismic energy efficiency to be significantly diminished relative to that of an equivalent yield contained detonation. The spectral composition of the ground motion generated by a cratering detonation is characterized by a lower amplitude level and a shift to the low frequency end of the spectrum. The general deficiency of high frequencies causes the peak vector particle velocities and accelerations to be lower than mean values predicted on the basis of experience with equivalent yield contained detonations. The peak vector particle velocity correlates almost exclusively with the surface wave mode time window for cratering detonations. The level of peak vector particle acceleration and velocity recorded from a cratering detonation at instrument sites located on alluvium is significantly reduced, relative to that of equivalent yield contained detonations, as a consequence of the lower seismic energy efficiency and the reduced high frequency spectral composition. The Schooner detonation provides data which will be useful in the prediction and analysis of future nuclear cratering detonations. (auth)

36444 (PNE-908-F) PROJECT PALANQUIN SCIENTIFIC PHOTOGRAPHY. Wilson, D.; Brower, R. W. (EG and G, Inc., Las Vegas, Nev.). Sep 1967. Contract AT(29-1)-1183. 51p. Dep. CFSTI.

For Lawrence Radiation Lab., Livermore, Calif.

Project Palanquin was a Plowshare experiment conducted at the Nevada Test Site (NTS) on April 14, 1965 to obtain data on nuclear excavation. The instrumentation systems and operational procedures used to provide scientific photographic support of Palanquin are described. Results of analysis of the collected data are included. Conclusions and recommendations evaluating the experiment and suggesting future techniques are presented. (auth)

36445 (PNE-910-F) FINAL REPORT OF OFF-SITE SURVEILLANCE FOR PROJECT PALANQUIN. (Public Health Service, Las Vegas, Nev. Southwestern Radiological Health Lab.). May 1970. 128p. Dep. CFSTI.

The Public Health Service provided off-site surveillance in support of the Palanquin event conducted on April 14, 1965. This support consisted of tracking the effluent, monitoring radiation dosage to the off-site population, and collecting environmental samples (air, milk, water, and vegetation). The maximum off-site net gamma dose rate observed was 3 mR/hr and the maximum exposure on any film badge was 45 mR. The maximum concentrations of fresh fission products found on any air filter at an off-site populated location were 23,000 pCi/m^3 of gross beta and 3400 pCi/m^3 of ^{131}I. The maximum concentration of ^{131}I found in a milk sample was 11,000 pCi/1 and the maximum ^{131}I found in a water supply used for human consumption was 70 pCi/1. Selected off-site residents were brought to Las Vegas for whole body counting and the maximum measured thyroid exposure was 162 mR. Analyses of radiological data indicate that radioactive effluent arising from this event did not present any health hazard to the off-site population, based on presently accepted safety criteria established by the U. S. Atomic Energy Commission. (auth)

36446 (PNE-964) MEASUREMENTS OF SUBSURFACE AND CLOSE-IN SURFACE DYNAMIC EFFECTS, Project CABRIOLET. Marks, R. E. California Univ., Livermore. Lawrence Radiation Lab.). Oct 1969. 42p. (UCRL-50768). Dep. CFSTI.

Close-in measurements of stress history, shock velocity, free-field acceleration, surface velocity and cavity pressure were attempted on the Cabriolet Event, a 2.3-kt cratering detonation in a Nevada Test Site porphyry rock. The final results are presented and compared with data from previous detonations in hard rock. The instrumentation defined a three-part shock structure consisting of elastic, main and cracking fronts. A subsurface spall was observed 12.7 m below the surface at 36 msec, and a peak surface spall velocity of 31.5 m/sec was recorded at 75 msec. The gas acceleration phase appeared on the surface at 323 msec. The mound surface attained a peak velocity of 47.5 m/sec at the gas vent time (802 msec). The scaled subsurface accelerations agreed with the data from the Palanquin and Danny Boy cratering events. The stress measurements were compromised by the inhomogeneous medium and the detonation electromagnetic effects. The cavity pressure gages did not record significant pressure signals. (auth)

36447 (STI/PUB-21/38) PEACEFUL USES OF NUCLEAR EXPLOSIONS. Bibliographical Series No. 38. (International Atomic Energy Agency, Vienna (Austria)). 1970. 475p. IAEA $12.00.

A bibliography containing 1759 references to publications on peaceful uses of nuclear explosions for engineering, industrial, and scientific purposes and on the general aspects, economics, phenomenology, and radiological and seismic safety of such explosions is presented. Personal author, corporate author, and subject indexes are provided. (L.C.L.)

36448 (UCRL-13451) LIDAR OBSERVATIONS OF DEBRIS CLOUDS FROM NUCLEAR CRATERING DETONATIONS. Final Report. Collis, Ronald T. H.; Oblanas, John W. (Stanford Research Inst., Menlo Park, Calif.). Aug 1968. Contract AT(04-3)-115. 80p. (PNE-331). Dep. CFSTI.

For Lawrence Radiation Lab., Livermore, Calif.

Lidar (laser radar) observations of the debris clouds resulting from nuclear cratering detonations are described. Observations were made of the Cabriolet and Buggy events at the Nevada Test Site, Nevada, on 26 January and 12 March 1968, respectively. The lidar data were analyzed to obtain data regarding cloud position, dimensions, and reflectivity for various times after detonation. The application of lidar to the monitoring of nuclear detonation clouds is discussed and possible future approaches are recommended. (auth)

36449 (UCRL-Trans-10458) HYDROLOGICAL USES OF ISOTOPES PRODUCED IN UNDERGROUND NUCLEAR EXPLOSIONS FOR PEACEFUL PURPOSES. Izrael', Yu. A.; Rovinskii, F. Ya. Translated by R. Addis for Univ. of California Lawrence Radiation Lab., Livermore, from Meeting on Technical Aspects of Peaceful Uses of Nuclear Explosives, Vienna, Austria, March 2-6, 1970. 12p. (CONF-700305-3). Dep. CFSTI.

A study was made of the behavior of radioisotopes formed when an underground nuclear explosion is used to create a reservoir. It was concluded that these isotopes, and particularly ^{106}Ru, ^{90}Sr,

and tritium, can be useful tracers for ground water studies. (L.C.L.)

36450 PROCESS FOR RECOVERING PETROLEUM UTILIZING A NUCLEAR EXPLOSION. Natland, Manley L. (to Richfield Oil Corp.). U. S. Patent 3,506,069. 14 Apr 1970. Filed 23 Sep 1963.

A method is given for the recovery of petroleum from subsurface oil-bearing formations having an underlying limestone stratum using a nuclear explosion. The nuclear explosion device is detonated at a point such that the resulting cavity will extend towards the lower surface of the formation sufficient so that at least a substantial portion of the formation will fall into the cavity. The petroleum is then recovered from the oil-bearing formation. The petroleum can fall or drain into the cavity, and the formation is heated to a considerable extent and the viscosity of the petroleum is reduced rendering it more flowable. Another possible advantage is the latent heat released by contacting the calcium oxide with water to provide an exothermic reaction. (J.C.W.)

36451 IL TRATTATO CONTRO LA PROLIFERAZIONE NUCLEARE. (Treatise on Control of Nuclear Proliferation). Bettini, Emilio (ed.). Bologna; Societa Editrice il Mulino (1968). 216p.

The history of the drafting of the nuclear non-proliferation treaty is briefly outlined. The talks and statements of Giuseppe Medici, Minister of Foreign Affairs, made to the Senate and Chamber of Deputies concerning the nuclear non-proliferation treaty are compiled. The treaty itself is reproduced, and the Italian resolutions and declarations concerning the treaty are presented. The debates in the Senate and Chamber of Deputies are given. (J.S.R.)

Facilities and Equipment

Refer also to abstracts 36410, 36411, 36441, 36764, 37390, 38525, and 38591.

36452 (ANL-Trans-833) STUDY OF A REGENERATOR FOR A GAS TURBINE. Malherbe, J.; Lalarge D'Ervau, G. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Translated for Argonne National Lab., Ill., from French report. 14p. Dep. CFSTI.

Efforts devoted to defining regenerators of gas turbines for direct-cycle nuclear power plants are described. The thermodynamic study of the cycle permits the dimensional design of the regenerator to be related to the efficiency and consequently, it is shown that it is possible to optimize the characteristic parameters of the exchanger: pinching and pressure loss. A comparative study of different types of regenerators leads to the final choice of exchangers with smooth tubes of small diameter or plate exchangers. (auth)

36453 (BNWL-MA-3) RADIOLOGICAL DESIGN CRITERIA. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). 25 Mar 1970. 50p. Dep. CFSTI.

The Radiological Design Criteria Manual, prepared to assist management and design engineers in the planning and design of Battelle-Northwest buildings where radioactive materials or radiation generating machines are to be used, is presented. The criteria in this manual are intended to characterize the physical protective features which are required in the design or modification of such a building. These criteria, from a radiation protection point of view, relate to operability of the building within the rigorous protection standards applied to the work force. Since this manual will not necessarily satisfy all radiation safety requirements, the professional assistance of Radiation Standards, Safety and Standards Division, may be necessary. (auth)

36454 (EUR-4478) TEMPERATURE CONTROL OF IRRADIATION EXPERIMENTS BY CHANGES IN GAS PRESSURE. Hebel, W. (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)). 1970. 26p. (In German). Dep. CFSTI (U. S. Sales Only).

A process for setting the temperature of a heated (or cooled) body at a desired value and for controlling or adjusting this temperature as required is described. The process is based on the transfer of heat through a gas gap between parallel or concentric walls, where the heat conductivity of the gas is changed by means of its own pressure. For irradiations of material in test reactor BR2, Mol, an automatic temperature control system working on the same principle was constructed and successfully put into operation in the spring of 1969. (auth)

36455 (JUL-649-RB) FINAL REPORT ON THE TESTS ON A HELICALLY WOUND HEAT EXCHANGER FOR THE STEAM GENERATOR OF THE THTR. Scholz, F.; Meis, Th.; Groehn, H. G. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorbauelemente). Mar 1970. 78p. (In German and English). Dep. CFSTI (U. S. Sales Only).

Results of tests performed using the inner, shortened part of a coiled heat exchanger in a high pressure gas loop are reported. The tests covered the ranges of Reynolds numbers Re = 6,000 to 740,000. Air was used as heat carrier at 1 to 40 atm. Integral heat transfer and pressure drop were measured in the normal case in which all tubes are cooled. A simulated accident in which three of eight coils fail was analyzed. (J.R.D.)

36456 (MLM-1733(LD)) ALPHA FUELS ENVIRONMENTAL TEST FACILITY. (Mound Lab., Miamisburg, Ohio). [1970]. Contract AT(33-1)-Gen-53. 16p. Dep. CFSTI.

A facility for testing radioisotopic power sources is described. The capability of the facility includes vibration testing, shock testing, fire testing, pressure testing, burial testing, fluoroscopy vacuum environmental testing, and melting. (J.R.D.)

36457 (NCG-TR-12) CONVENTIONAL EXCAVATION METHODS AND COSTS FOR USE IN FEASIBILITY STUDIES OF NUCLEAR AND CONVENTIONAL EARTHWORK PROJECTS. Wills, John D. (Army Engineer Nuclear Cratering Group, Livermore, Calif.). Mar 1970. 258p. Dep. CFSTI.

Modern earthmoving projects require that close consideration be given to the planning and engineering of equipment systems. Although the use of nuclear explosives offers a new approach to moving huge quantities of material, conventional equipment would still be required for a substantial portion of the work. Information on current methods and costs of using conventional earthmoving equipment in conjunction with projects excavated by nuclear explosives is provided. However, the information is applicable to any large scale excavation project. The initial sections present introductory material and the basic fundamentals of estimating the costs for earthwork excavation. The principles of selecting an equipment system and the major items of equipment which might be used on a major earthwork project are discussed. The Appendices contain references, supplemental information on price adjustment factors and illustrative problems. (auth)

36458 (NYO-4095-1) VAPOR COMPRESSIBILITY EFFECTS IN HEAT PIPES. Progress Report No. 1. Levy, Edward K.; Chou, Shyan-Fu (Lehigh Univ., Bethlehem, Pa. Dept. of Mechanical Engineering). May 1970. Contract AT(30-1)-4095. 76p. Dep. CFSTI.

The preliminary results from an analytical study of the effect of vapor dissociation and vapor supersaturation on the sonic velocity limit in sodium heat pipes are presented. For a sodium vapor flow which is in chemical equilibrium but which is frozen with respect to liquid-vapor phase change, computed values for the maximum rate of heat transfer based on the sonic limit and for the axial drop in heat pipe temperature are presented and are shown to be in good agreement with recent experimental results from the literature. A comparison between the chemical equilibrium, reacting, and frozen flow analyses shows small variations in maximum heat transfer rates but large differences in the amounts of vapor supersaturation. (auth)

36459 (ORNL-TM-2732) FILLING HEAT STORAGE TUBES FOR SOLAR BRAYTON-CYCLE HEAT RECEIVER WITH LITHIUM FLUORIDE. Gnadt, P. A. (Oak Ridge National Lab., Tenn.). Jul 1970. Contract W-7405-eng-26. 86p. Dep. CFSTI.

A facility was designed, fabricated, and operated to fill Nb-1% Zr tubes with liquid lithium fluoride. Sixty-nine heat storage tubes were processed for a solar heat receiver that is a major component for a NASA solar-heated Brayton-cycle power unit. This 2- to 15-kW(e) dynamic power conversion system will eventually be used for earth orbit application. The lithium fluoride will provide heat storage capability for the shadow portion of the orbit. The salt-filled heat storage tubes described here were prepared for a prototype system to be tested in the NASA Plumbrook Facility by using a solar simulator. The lithium fluoride was introduced into the annulus between a bellows-like outer tube and an inner gas duct that will carry the Brayton-cycle working fluid, a helium-xenon mixture (mol. wt = 84). The 48 Nb-1% Zr tubes required for the actual system were filled with the molten salt, as well as eleven spares, six heat transfer test specimens, three thermal-cycling test specimens, and one preliminary test piece. The process required the use of a 120-ft^3 10-ft-high vacuum chamber, refractory metal jigs and fixtures, highly purified lithium fluoride at temperatures up to 1750°F, and much of the technology developed for the handling of high-melting-point salts (LiF m.p. = 1560°F). (auth)

36460 (UCRL-50863) DESIGN OF A 36-INCH MITER VALVE. Holl, P. M.; Kopytoff, V. (California Univ., Livermore. Lawrence Radiation Lab.). 28 Apr 1970. 14p. Dep. CFSTI.

The design and fabrication of a unique gas valve are described. The valve has two gas-driven doors that shut against the mitered end of a 36-in. pipe. The doors move from fully opened to fully closed in 35 msec and are designed to seal against a pressure differential of 1600 psi. Complete with operating systems, the valve is 58.5 in. in diameter and 10 ft long. It carries a 400,000-lb axial load and functions while buried in earth. It is actuated remotely, and the positions of its doors are continuously monitored. The major static and dynamic components are arc-welded steel fabrications. (auth)

36461 (WANL-TME-2688) THEORY AND STRUCTURAL DESIGN APPLICATIONS OF WEIBULL STATISTICS. DeSalvo, G. J. (Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.). [1970]. 104p. Dep. CFSTI.

The basic theory of Weibull statistics and its application to structural design are described. Included is a description of the Weibull parameters and their effects on design considerations. Several methods of reducing fracture data to obtain the Weibull parameters are described and compared. The size and stress distribution effects predicted by Weibull's theory are presented in detail along with working curves which may be used in design. Relationships between reliability and safety factor and methods of determining allowable material strengths are presented. Several example problems illustrating the use of Weibull statistics in design considerations are also included. (auth)

36462 APPARATUS FOR PROCESSING THE ENDS OF A NEST OF TUBES FROM A REMOTE LOCATION. Peyrot, Jean-Pierre; Thome, Paul (to Commissariat a l'Energie Atomique). British Patent 1,189,757. 29 Apr 1970. Priority date 2 Jun 1967, France.

The design is given of remote handling equipment for maintenance or welding of the ends of a nest of tubes. Defective tubes may be repaired quickly by the apparatus. (J.C.W.)

36463 PACK OF IMPACT-SENSITIVE MOULDINGS. (to Nukem-Nuklear-Chemie und-Metallurgie Gesellschaft mbH). British Patent 1,190,279. 29 Apr 1970. Priority date 26 Oct 1966, Germany.

The design is given of a pack for an economic packing of impact-sensitive moldings. The pack may be used for uranium pallets for circular fuel elements or catalyst elements of a porous ceramic material. The fragile sintered products have to be protected against damage during transportation. Dead weight has to be kept to a minimum, relative costs kept low as possible, loading and unloading procedures economically performed, and regulations governing radioactive packing procedures observed. Pallets may be stacked one above the other with thin sheets of elastic material in between. (J.C.W.)

36464 EQUIPMENT FOR A VERY HIGH VACUUM. Hnilicka, M. P. Jr.; Simons, J. C. Jr. (to Norton Co.). German Patent 1,285,091. 12 Dec 1968. Filed 2 Jan 1964.

A device to create a very high vacuum is described. It has an external container to which a vacuum pump is connected by an orifice. The vacuum pump interlocks telescopically in the external container which is cooled cryogenically. The vacuum chamber is evacuated with a diffusion pump through an evacuation orifice. (J.S.R.)

36465 IMPROVEMENTS IN OR RELATING TO FLUIDISED BED APPARATUS. Flamm, Hermann Jakob (to United Kingdom Atomic Energy Authority). British Patent 1,191,939. 13 May 1970. Filed 9 Oct 1967.

Reference is made to fluidized bed apparatus for the coating of particulate material, including coating with pyrolytic carbon SiC by deposition from a gas. With a view to minimizing deposition of carbon on the walls and other surfaces adjacent to the process gas injection point dual aperture nozzle arrangements have been proposed with the object of distributing a flow of inert fluidizing gas over the surfaces of the bed around the reaction zone. Difficulties arise, however, in arriving at a design in which a high degree of concentricity of coaxial flow passages is preserved and whereby a uniform distribution of inert gas can be achieved. The apparatus described comprises a process vessel, a gas injection assembly having coaxial inlets for fluidizing and process gases, the inlet for fluidizing gas being arranged to inject gas around the process gas inlet in a number of separate streams, some of which are directed over the process gas injection orifice and others over the interior surface of the process vessel. The inlet for process gas may comprise a tube having external longitudinal grooves providing coaxial channels for fluidizing gas. Near its mouth the tube preferably has a ferrule which serves to divide the flow from the grooves into two annular jets, one of which discharges around the mouth of the tube; the other jet may be located between the ferrule periphery and a flared extension of the bore in the bottom of the vessel through which the tube protrudes. In this arrangement the annular discharge clearances for the jets are preserved accurately coaxial. A number of alternative design details are described. (UK)

36466 BASIC RADIOGRAPHY. 10. RADIATION PROTECTION. Mendoza, A. (West Midlands Regional Office, Birmingham, Eng.). Non-Destruct. Test.; 3: No. 3, 188-93(Jun 1970).

The design of an enclosure for use with X and gamma rays so that the maximum permissible radiation dose rates laid down in statutory regulations are not exceeded is described. Some of the pitfalls and areas of difficulty wherein the regulations might be inadvertently contravened are discussed at each stage of the design procedure. (auth) (UK)

36467 NOVA INTERFACE EQUIPMENT (16 Jun 1970) (Engineering Materials). (Los Alamos Scientific Lab., N. Mex.). (CAPE-2007).

18 drawings.

Interfacing equipment used with the small NOVA computer at the linear accelerator in the Los Alamos Meson Physics Facility is described. NOVA is a digital computer which is used to facilitate the control, data acquisition, data processing, and data display of beam diagnostics. Several of the standard circuit cards for the interface, which include the cards for the code generator, status, data channel, bus driver, bus driver receiver, and the level converters, should prove to be useful in other equipment of this type. (For details see TID-4100 Suppl. 59) (F.S.)

36468 COMPARISON OF DIFFERENT CONVERTOR DRIVES FOR COOLANT PUMPS IN REACTORS. Wirth, Wolfgang (Versuchsatomkraftwerk, Kahl, Ger. Heissdampfreaktor, Grosswelzheim, Ger.). At. Strom.; 16: 81-5(May 1970). (In German).

Various convertor circuits for dc or three-phase ac motors are compared and their pros and cons from the point of view of the operation discussed. So far three-phase ac motors have been mainly used for circulating-pump drives for coolants, but recently dc motors have also been adopted for this purpose. (auth)

36469 NEUTRON RADIOGRAPHIC STUDY OF LIMITING PLANAR HEAT PIPE PERFORMANCE. Moss, Richard A. (Massachusetts Inst. of Tech., Cambridge); Kelly, Arnold J. Int. J. Heat Mass Transfer; 13: 491-502(Mar 1970).

A condition limiting the maximum heat transfer rate attainable by heat pipes was investigated experimentally. Using neutron radiographic techniques, a detailed investigation of the vaporization processes which occur interior to the wick structure of a planar heat pipe employing water as a working fluid was conducted for a number of wicks having different mean pore sizes and for several angles of inclination of the wick. The neutron radiographic system employed permitted measurements of the liquid layer thickness in the wick, to be made with an accuracy of 0.006 in. for thicknesses up to 0.125 in. of water, and with a lateral resolution of 0.0135 in. Two models of the heat transfer process occurring in planar heat pipes were postulated and analytically formulated. The first model assumed that evaporation occurred only from the upper surface of the wick whereas the second assumed that vapor was generated at the wick's base and released solely from the sides of the wick. With a secondary assumption of variable pore size, the second model proved to be more realistic for correlating the test date than the first. The apparent variation of pore size, indicated by the data to be a function of heat transfer rate, was interpreted as a manifestation of the "Leverett effect". (auth) (UK)

36470 STUDY OF HOT HARDNESS OF PURE IRON AND PURE TANTALUM BY A NEWLY DEVELOPED ULTRA HIGH TEMPERATURE HARDNESS TESTER. Yoda, Renpei (National Research Inst. for Metals, Tokyo); Sato, Yuichi; Mashimo, Misao; Yamanouchi, Sadamu. J. Jap. Inst. Metals; 34: 526-33(May 1970). (In Japanese).

An ultra high temperature hardness tester which is capable of reading the hot hardness value up to 1700°C was devised recently. The hardness tester was shielded from the high light scattering from the ultra highly heated specimen, and the impression image was obtained by reflected electrons from a scanning type electron microscope. The specimen surface image, therefore, was clearly visible over the whole temperature range. The specimen temperature was elevated by electron bombardment up to 2000°C and the temperature was calibrated by observing surface images of various pure metals in the melting and solidifying states. For example, the image of 3.8 mmg of pure platinum(mp 1770°C) was clearly observed during the melting procedure. An indenter was located inside the heating furnace, so both specimen and indenter

tip were heated to the desired temperature. The indenter tip temperature, therefore, was elevated sufficiently before applying a dead weight to a specimen. In a general relation between the hot hardness value and temperature for pure iron and pure tantalum, the inflection points were at lower temperatures than those in the previous data. Most of the hot hardness values for pure iron were also slightly lowered in high temperature range over the inflection point. The creep effect on the hot hardness was obviously recognized at the temperatures over the inflection point, but this effect may not extend over the temperatures below 500°C for pure iron. And a higher hot hardness value was always observed under a lower test load except over 800°C. The all-sapphire indenter gave a higher value of hot hardness than the sapphire tipped indenter. This result may also be considered the difference of thermal conductivity from the all-sapphire and sapphire tipped indenters. Hot hardness measurements were long done with the diamond tipped indenter which gave a much higher value of hardness. Diamond had a higher thermal conductivity than sapphire and was apt to react with various metallic specimens at higher temperatures. Moreover, the use of the higher test load was not suitable for an accurate measurement of hot hardness because of the possibility of thermal drift between a specimen and the indenter tip and the promotion of the creep effect. Therefore, it seems more desirable to conduct the hot hardness measurement under a constant test load as low as 50 g with the all-sapphire indenter. (auth)

36471 IMPROVEMENTS IN SEALED JOURNAL BEARINGS. Hopkins, Shirley Russell (to United Kingdom Atomic Energy Authority). British Patent 1,196,553. 1 Jul 1970. Filed 7 Mar 1968.

Reference is made to sealed journal bearings for shafts, spindles with particular application to cases where leakage must be prevented, such as for toxic, radioactive or high value material, or where the material is incompatible with the outside atmosphere. The bearing described has a body member in which the shaft can rotate, and two annular fluid seals adapted to make sealed contact with the shaft. The seals are spaced axially relative to the shaft to provide an interspace, the journal bearing for the shaft being positioned within the interspace. Means are provided for applying a barrier fluid under pressure to the interspace, together with sensing means for detecting change of barrier fluid pressure within the interspace. The barrier fluid should be compatible with both the contained and the outside atmosphere. The body member may comprise two separate coaxial parts, with an annular fluid seal in each part, separate sealing means being provided to establish a barrier fluid seal between the parts of the body member. The sensing means may comprise a duct communicating between the interspace and an outside face of the body member and a pressure transducer acting as sensor. The supply duct for the barrier fluid may be located so as to extend to the interspace from an outside face of the body member, with a non-return closure for the outside face end. The body member, or a part thereof, may comprise a catchpot on the opposite side of at least one fluid seal to the interspace, and adapted to co-operate with means for promoting flow into the catchpot of any barrier fluid which may have passed the seal from the interspace. The barrier fluid may be a lubricant for the journal bearing for example grease. (UK)

36472 IMPROVEMENTS IN OR RELATING TO GLOVE BOXES, DRY BOXES AND FUME CUPBOARDS AND THE LIKE. Howarth, A. J. (to United Kingdom Atomic Energy Authority). British Patent 1,196,876. 1 Jul 1970. Filed 10 Oct 1968.

The boxes and cupboards described have a rigid polyvinyl chloride (PVC) beading framework, with panels of transparent material mounted in channels in the framework. The framework and panels are bonded together, for example by welding or cement. The panels may also be of PVC, although other transparent materials may be used, and may comprise two layers of plastic material with liquid between the layers to provide β-radiation shielding; the liquid may be water or zinc bromide. (UK)

36473 IRRADIATION APPARATUS FOR MICROBIOLOGICAL EXPERIMENTS WITHOUT EXTERNAL HAZARDS. Frankenberg, Dieter; Heigwer, Gerhard; Pohlit, Wolfgang (Gesellschaft fuer Strahlenforschung mbH, Frankfurt am Main). Strahlentherapie; 139: 379-84(Mar 1970). (In German).

The design of an irradiation device for microbiological experiments is described. The device consists of an x-ray tube, a radiation protection device, an ionization chamber, a digital recording dosimeter and a thermostat with a stirring apparatus. The radiation protection device is constructed in such a way that an approachable control region doesn't exist. The ionization chamber and the digital recording dosimeter render an accurate dosimetry. (auth)

36474 FILTER FOR GAS FLOWING IN A HOT CELL. Naumann, Paul (to European Atomic Energy Community). British Patent 1,196,361. 24 Jun 1970. Priority date 2 Mar 1967, Belgium.

A filter and locking device is described for use in hot cell ventilation ducts. The filter can be put in place and locked or unlocked and removed using only axial or rectilinear movements. The device can be used to automatically seal the cell. (J.R.D.)

36475 FILTER EFFECTIVENESS FOR RADON DECAY PRODUCTS. Herrmann, D. B. (Staatliche Zentrale fuer Strahlenschutz, Berlin). Naturwissenschaften; 56: 634(1969). (In German).

Various filters are measured with respect to retention of radon and its daughter products. Significant differences were found even for filters of the same manufacturing source. Therefore, the assumption of a 100% retention cannot be maintained. (H.B.G.)

36476 CONSTRUCTION OF COMPENSATORS FOR COBALT TELETHERAPY. Khan, Faiz M.; Moore, Vaughn C.; Burns, Dennis J. (Univ. of Minnesota, Minneapolis). Radiology; 96: 187-92(Jul 1970).

Methods are proposed to construct compensators for irregular body contours and oblique γ beam incidence. In the former case a compensator can be constructed in a single piece, provided a suitable material of reduced density (to compensate for reduction in scattered radiation) is used. Suitable density factors were determined for various mounting distances of a compensator. The use of brass compensating wedges was suggested, specifically for γ radiation beams incident obliquely on a flat surface. The correction factors for beam divergence and reduction in scatter were incorporated in the calculation of wedge angles. (auth)

36477 INFLUENCE OF SLIGHT CURVATURE ON THE BENDING BEHAVIOUR OF A ROTATING SHAFT. Leinonen, Tatu E. (Oulu Univ., Finland). Acta Polytech. Scand., Mech. Eng. Ser.; No. 47, 1-43(1969).

Results are used to extend the classical theory by taking into account a slight curvature of the shaft. The slight curvature is approximated by a finite Fourier series. A theoretical model is developed which illustrates the behavior of the shaft during rotation. It was observed that the solutions from this model were unique except at discrete values of the rotation speed. Two special cases from this general theory are considered in detail. A practical method for estimating the maximum bending moment is included. An example of its application to a shaft design problem is given. (auth) (Sweden)

36478 CRITICAL SPEED OF A SHAFT AS INFLUENCED BY THE SUPPORTS. Vaeisaenen, Seppo K. (Technical Univ., Otaniemi, Finland). Acta Polytech. Scand., Mech. Eng. Ser.; No. 48, 1-62(1969).

A study is made of the critical speeds of a shaft with non-zero mass supported at both ends when the elastic displacements of the bearings transversal as well as in slope are assumed to be non-linear. The general deformation equations, which are valid both in respect of flexural vibration and of various composite rotary motions, are derived by applying the expressions presented by Timoshenko. Dampings were neglected. The case of non-linear bearing conditions do not lead to a linear eigenvalue problem as do the ideal and linear cases. In order to find an approximate solution of the problem, the amplitude of deflection of the shaft corresponding to each speed of rotation is considered to be critical at which the amplitude in question exceeds a given allowable deflection which is maximal e.g., from the viewpoint of operation of the machine, or at which alternatively the marginal stress exceeds a given, dangerous value. The computer program used is applicable in determining the combined effect exerted on the deflection and marginal stress of the shaft by the transversal and slope elasticities, consistent with elasticity graphs of arbitrary shape, of bearings of various types and of their supports. (auth) (Sweden)

36479 ANALOG SIMULATION OF MIXER-SETTLERS. Kikindai, T.; Michel, P.; Rouyer, H.; Chazal, G. pp 214-19 of Analog and Hybrid Computation Applied to Nuclear Energy. Brussels, Presses Academiques Europeennes (1969). (In French).

From International Symposium on Analogue and Hybrid Computation Applied to Nuclear Energy, Versailles, France. See CONF-680941.

An analog simulation of mixer-settlers was formulated for the extraction of uranium from nitric acid solutions by an active organic solvent. Three types of perturbations were considered: output perturbations, concentration perturbations, and perturbations caused by external variables such as temperature. The simulation

required the mathematical description of the chemical equilibrium and a description of the settler. The equations from the mathematical descriptions were subjected to two analog solutions. The second solution is much more stable and the results are in good agreement with experimental results. The calculated response of an extraction section to a sharp increase of acidity in the feed is given as illustration of the analog simulation. (J.S.R.)

36480 DYNAMIC STUDY AND REGULATION OF A URANIUM EXTRACTION BATTERY SUBJECTED TO SMALL-AMPLITUDE PERTURBATIONS. Bory, Michel; Degryse, Michel. pp 220-3 of Analog and Hybrid Computation Applied to Nuclear Energy. Brussels, Presses Academiques Europeennes (1969). (In French).

From International Symposium on Analogue and Hybrid Computation Applied to Nuclear Energy, Versailles, France. See CONF-680941.

An analog study was made of the dynamic behavior and regulation of a mixer-settler uranium separation system subjected to small-amplitude perturbations. The system makes up a portion of a plant for the treatment of irradiated nuclear fuels. Its function is to separate uranium and plutonium from fission products. The base equations for one stage of a three-section battery were derived and simplified for processing on an analog computer. The analog equations and scheme corresponding to one stage were derived. Tests were made of simple perturbations. The results showed that the mathematical results obtained had errors less than 1% of the amplitude of the perturbation. The mathematical model itself, however, was the source of significant errors. It was concluded that it would be difficult to improve the analog representation, but that the use of a hybrid computer would give a better representation of the system. (J.S.R.)

36481 ANALOG STUDY OF THE DYNAMICS OF A PLANT FOR THE SEPARATION OF CHEMICAL PRODUCTS. Bentajou, J. (CEN, Saclay, France); Chareton, H.; Di Falco, Ch.; Jacques, R. pp 224-8 of Analog and Hybrid Computation Applied to Nuclear Energy. Brussels, Presses Academiques Europeennes (1969). (In French).

From International Symposium on Analogue and Hybrid Computation Applied to Nuclear Energy, Versailles, France. See CONF-680941.

An analog study was made of the dynamics of a plant for the separation of chemical products; the method used is based on a combination of the approximation analog method and a linear model solved on a numerical computer. The phenomena to be studied are formulated mathematically and the method of resolution is described. Studies were made on the case of a shaped plant and the case of a column. Generally, the analog method gives results comparable to the method proceeding by matrix inversion and numerical integration. The analog calculation is much more rapid and precise. (J.S.R.)

Heat Transfer and Fluid Flow

Refer also to abstracts 36385, 36455, 36458, 36459, 36469, 36508, 36519, 37006, 38492, 38516, 38517, 38587, and 38637.

36482 (ANL-Trans-834) NUMERICAL CALCULATION METHOD TO SIMULATE THE DYNAMIC AND THERMAL BEHAVIOR OF A COMPRESSIBLE FLUID IN A CLOSED CIRCUIT IN A VARIABLE STATE. Rousseau, J. C.; Dobremelle, M. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Translated for Argonne National Lab., Ill., from French report. 13p. Dep. CFSTI.

The equations of momentum, continuity, and conservation of energy are applied to a closed circuit traversed by a gas, consisting of energy generators, ducts, exchangers, and blowing equipment. The calculation permits determination of the flow rate, pressure, and temperature of the gas along the entire circuit as well as the wall temperatures as a function of a known variation of the generator power, the blowing output, and the operating conditions of the exchangers. An application is made to determine the behavior of a natural uranium-graphite-gas nuclear reactor for which the exchangers are located below the core-energy generator, when the blowers stop. The calculation permits a prediction of the instabilities and flow inversions in the circuit which can interfere with correct cooling of the power plant. (auth)

36483 (NYO-3109-48) CHARACTERISTICS OF A HEATED JET DISCHARGED HORIZONTALLY INTO A TRANSVERSE CURRENT. PART I. CONSTANT DEPTH. Technical Report 61. Carter, H. H. (Johns Hopkins Univ., Baltimore, Md. Chesapeake Bay Inst.). Nov 1969. Contract AT(30-1)-3109. 40p. Dep. CFSTI.

Results of investigations concerning the behavior of heated discharges of water jetted at right angles into a moving streams of water are presented. The discharge canal is rectangular. The jet stream and the receiving waters are confined vertically by the sea surface and the sea bottom. A mathematical analysis of the results is included. (J.R.D.)

36484 (RD/B/N-1585) INITIATION OF BOILING IN SUPERHEATED LIQUID SODIUM. Holland, P. K.; Winterton, R. H. S. (Central Electricity Generating Board, Berkeley (England), Berkeley Nuclear Labs.). Feb 1970. 24p. Dep. CFSTI (U. S. Sales Only).

The various mechanisms that can initiate boiling in superheated liquid sodium, which are relevant to the fast reactor, are discussed. Only nucleation at a pre-existing gas or vapour bubble is considered feasible. Parameters that influence the effectiveness of these nuclei are investigated. Two of these, gas bubbles and tribonucleation, are capable of preventing significant superheat. Experimental study of these is proposed. (auth) (UK)

36485 (UCRL-50820) THE OGRE CODE: A TWO-DIMENSIONAL NUMERICAL MODEL OF THE TRANSIENT FLOW OF ONE OR TWO COMPRESSIBLE FLUIDS THROUGH CONFINED POROUS MEDIA. Korver, John A. (California Univ., Livermore. Lawrence Radiation Lab.). 11 Feb 1970. 229p. Dep. CFSTI.

The OGRE code was originally developed to evaluate the effects of nuclear stimulation of oil and gas reservoirs. As a result, the mathematical model follows closely some of the two-dimensional models used by the petroleum industry. The nomenclature also follows that used by the industry but, since the processes being analyzed are the same as those which take place in the viscous flow of any fluid through porous media, the model can be used for a more general class of problems. Analysis is carried out by the solution of finite difference approximations to the differential equations describing the flow of one or two compressible fluids in the vertical plane. The medium may be homogeneous or heterogeneous and, in the heterogeneous case, several standard geometries or a random distribution of permeability and porosity may be used. Like many working codes, OGRE is in a continuing process of modification, and thus the presentation here represents its current form. (auth)

36486 BUBBLE GROWTH RATES. Mikic, B. B.; Rohsenow, W. M.; Griffith, P. (Massachusetts Inst. of Tech., Cambridge). Int. J. Heat Mass Transfer; 13: 657-66(Apr 1970).

A simple general relation for bubble growth rates in a uniformly superheated liquid was derived. The relation is valid in regions of both inertia controlled and heat diffusion controlled growth. The derived relation is compared with the existing experimental results for bubble growth in a uniformly superheated liquid with very good agreement. The results are further extended to the bubble growth in a non-uniform temperature field which approximates the conditions present in a nucleate boiling from a heated surface. (auth)(UK)

36487 STEAM VOLUME FRACTION IN TWO PHASE FLOW. III. ROD BUNDLE GEOMETRY. Michiyoshi, Itaru; Serizawa, Akimi (Kyoto Univ.). Nippon Genshiryoku Gakkaishi: 12: 311-16(1970). (In Japanese).

The steam volume fraction of a two phase mixture was measured in the low quality and low mass velocity region, as the fluid flowed upward under atmospheric pressure in 4-rod and 7-rod bundle geometries of triangular lattice (9.5 mm OD and 1 m long, 1.37 and 1.79 p/d ratio). The experiments were performed with use made of a capacitance-type void meter, and by supplying various heat inputs into each rod heater. The results indicate that: in the bubble flow region, a significant peaking in void fraction was observed in the transition to slug flow in all the experimental runs, and that this is probably related to the effects of turbulent interchange and diversion cross-flow between adjacent subchannels, under conditions of two phase flow; and in the slug flow and annular flow regions with large disturbance waves, 4-rod bundle data were 5% lower than those in circular tube and concentric annulus, and 7-rod bundle data 10% lower. These results can be explained by Griffith's correlation with bubble rising velocity, in which channel geometries are considered. Taking account of channel geometry, the previously proposed correlation is also valid in predicting the void fraction in rod bundle geometries. (auth)

36488 HEAT CONDUCTION WITH INTERNAL SOURCES BY MODIFIED MONTE CARLO METHODS. Thompson, J. J.; Chien, P. Y. P. (Univ. of New South Wales, Kensington). Nucl. Eng. Design; 12: 207-14(1970).

To estimate local steady state temperatures in heat generating reactor components, several efficient modified Monte Carlo methods have been developed. One of these is shown to be the theoret-

ical optimum (zero variance) method for internal source problems Numerical studies of a simple two-dimensional problem confirm the expected improvements in efficiency over classical Monte Carlo, and permit a comparison with the Exodus method. (auth)

36489 HEAT TRANSFER IN HEAT GENERATING FLUID WITH FLAT VELOCITY PROFILE AND ARBITRARY FLUID INLET AND CIRCUMFERENTIAL WALL TEMPERATURE DISTRIBUTION. PART II. Di Federico, I. (Univ., Bologna). Nucl. Eng. Design; 12: 180-4(1970).

Solutions obtained in a previous article are developed for the case of cosinusoidal wall temperature distribution. Nusselt numbers based on mean wall temperature are reported for different values of the heat-generation rate. (auth)

36490 FLOW-INSTABILITY-INDUCED BURN-OUT OF NON-UNIFORMLY HEATED CHANNELS WITH A CONSTANT PRESSURE DROP. Kreyger, P. J.; Essler, W. A. (Commission of the European Communities, Petten, Netherlands). Nucl. Eng. Design; 12: 148-52(1970).

The suggestion of Whittle and Forgan on the similarity of bubble detachment and flow instability is further investigated and found to be confirmed by experimental results reported in literature. Since the criterion for the detachment of vapor bubbles from a heated surface is determined by the local conditions, it is proposed to apply this criterion when predicting flow instability induced burn-out of non-uniformly heated channels. (auth)

36491 EXPLICIT CALCULATION OF A TWO-PHASE FLUID FLOW IN A CHANNEL. Prisnyakov, Vladimir (CEA, Grenoble, France). Compt. Rend., Ser. A; 270: 967-9(13 Apr 1970). (In French).

The general scheme of calculation of a one-dimensional and stationary flow of a boiling fluid in a cylindrical channel, previously presented is developed here. The curves obtained are in good agreement with other author results for values of z (section abscissa) between 0 and 150. The scheme proposed may therefore be used for an approximate calculation of two-phase fluid flows of low titer. (auth) (France)

36492 THEORETICAL ANALYSIS OF BUBBLE DYNAMICS FOR AN ARTIFICALLY PRODUCED VAPOR BUBBLE IN A TURBULENT STREAM. Robin, Theodore T.; Snyder, Nathan W. (North American Rockwell Corp., El Segundo, Calif.). Int. J. Heat Mass Transfer; 13: 523-36(Mar 1970).

A mathematical model is given for an artificially produced vapor bubble growing on a surface and into a turbulent subcooled stream flowing parallel to the surface. This model was tested for steam injection through a 0.0135 in. hole in a stainless steel plate and into a water stream with Reynolds numbers from about 0.9×10^4 to 2.0×10^5, inlet bulk temperatures from 80 to 140°F, and near atmospheric pressure. Under these conditions, about 4000 bubbles per sec were formed with a 0.02 to 0.03 in. radius. Heat transfer per bubble varied from about 1×10^5 to 5×10^5 Btu. Basic considerations of bubble dynamics for this model are discussed. Condensation at the bubble vapor-turbulent stream interface is a major component of this model. Subsequent diffusion of the associated latent heat into the turbulent stream was also important. Mathematical equations are given, and the method of solution is indicated. Agreement with experimental results demonstrates the validity of this model and the method of solution. (auth) (UK)

36493 ENTRANCE REGION AND VARIABLE HEAT FLUX EFFECTS IN TURBULENT HEAT TRANSFER TO LIQUID METALS FLOWING IN CONCENTRIC ANNULI. Chen, John C.; Yu, W. S. (Brookhaven National Lab., Upton, N. Y.). Int. J. Heat Mass Transfer; 13: 667-80(Apr 1970).

An analytical solution was obtained for the turbulent entrance-region problem with a step-function heat flux distribution. Necessary eigenvalues, eigenfunctions, and series coefficients were evaluated from the characteristic equation by the method of Runge-Kutta. Calculated Nusselt numbers in the entrance region were found to be in general agreement with recent experimental measurements. The solution was then generalized to include cases of arbitrarily varying heat flux by means of Duhamel's integral, and sample results were obtained for cases of linear and sinusoidal heat flux distributions. Emphasis was placed on low-Prandtl-number fluids, though the solution is general and some sample calculations were made for fluids of moderate Prandtl numbers. (auth) (UK)

36494 ANNUAL REVIEW OF FLUID MECHANICS. VOLUME 2. Van Dyke, Milton; Vincenti, Walter G.; Wehausen, J. V. (eds.). Palo Alto, Calif.; Annual Reviews, Inc. (1970). 468p. $10.00.

The 15 articles in this volume treat the following topics: boundary layers, numerical models, analogy between rotating and stratified fluids, ship hydrodynamics, nonlinear wave propagation, two-phase systems, porous media, tides, weather prediction, ocean circulation models, solar-wind flow, vibrational relaxation in gas-dynamic flows, and dusty gases. A separate abstract was prepared for the article on solar-wind flow past objects in the solar system. (D.L.C.)

For an abstract of one section see: 37111.

36495 DYNAMIC ANALYSIS OF COUNTERFLOW AND PARALLELFLOW HEAT EXCHANGER. Feretic, D. (Inst. Djuro Djakovic, Zagreb). Atomkernenergie; 16: 1-5(1970).

The frequency method of analysis is applied to study the dynamic characteristics of counterflow and parallelflow heat exchanger. From partial differential equations transfer functions of heat exchangers are derived. These transfer functions are then analyzed, by using a digital computer, for a wide frequency spectrum of fluctuation of heat exchanger primary water inlet temperature. An additional computer program is elaborated to transform the frequency response data into the step response data of the system. Both theoretical and experimental results are included. Results of the theory are compared with the experiment and a favorable agreement is obtained. (auth)

36496 INTERPRETATION OF SOUND VELOCITY IN TWO PHASE MIXTURES. Kawai, Toshio (Hitachi Central Research Lab., Kawasaki, Japan). J. Nucl. Sci. Technol. (Tokyo); 7: 317-20(Jun 1970).

Pressure propagation phenomena in regularly spaced two-phase layers is discussed from theory. The value for sound velocity becomes that usually expected for a homogeneous compressible medium in the limiting case where the thickness of each layer is small compared with the wave-length. There must be a sufficient number of layers for the homogeneous concept to hold. Otherwise dispersion is expected. (auth)

36497 HYDRAULIC IMPEDANCE: A TOOL FOR PREDICTING BOILING LOOP STABILITY. Anderson, T. T. (Argonne National Lab., Ill.). Nucl. Appl. Technol.; 9: 422-33(Sep 1970).

The hydrodynamics of coolant flow in a natural circulation, nuclear-heated boiler are dependent upon interactions of the generated heat, the available driving head of vapor in the two-phase mixture, and flow of the coolant. Where at steady operating conditions a slight increase in heat generation will induce unstable flow, circulation hydrodynamics can be investigated by small-signal techniques of control system theory. The flow-pressure interaction can be described in terms of the hydraulic impedance which is the frequency-transformed ratio of two perturbed quantities, differential presssure over flow rate. The hydraulic impedance is analogous to acoustic impedance (acoustic pressure/particle velocity) of compressible media and to mechanical impedance (force applied to structure/resulting velocity) of rigid body mechanics. Measurements of the flow-vapor interaction and of the flow-pressure interaction (hydraulic impedance) are compared to a simplified theory, to demonstrate how the impedance approach aids understanding of complex two-phase phenomena. As a practical application, the flow stability of a boiling loop is predicted by measured hydraulic impedances. (auth)

36498 ANALOG SIMULATION ASSOCIATED WITH THICK ANNULAR HEAT EXCHANGERS. Renard, Guy; Ta Phuoc Loc pp 139-43 of Analog and Hybrid Computation Applied to Nuclear Energy. Brussels, Presses Academiques Europeennes (1969). (In French).

From International Symposium on Analogue and Hybrid Computation Applied to Nuclear Energy, Versailles, France. See CONF-680941.

The association of an analog computer with an active lattice was applied to the solution of the problem of thick annular heat exchangers. The first authorized the representation of tridimensional fields and the other that of non-linearity and of initial conditions at any limits. The preliminary studies showed that the coupling of an analog computer to an active lattice is a method that will permit the development of modular thermal simulators and of their use in the representation, identification, or optimization of very rapid thermal phenomena. (J.S.R.)

36499 DESIGN AND CONSTRUCTION OF A MODULAR SIMULATOR FOR TRANSIENT HEAT EXCHANGER SYSTEMS. Pakleza, Jaroslaw. pp 153-6 of Analog and Hybrid Computation Applied to Nuclear Energy. Brussels, Presses Academiques Europeennes (1969). (In French).

From International Symposium on Analogue and Hybrid Computation Applied to Nuclear Energy, Versailles, France. See CONF-680941.

A study was made of the development of a thermal simulator permitting the study of problems relative to an assembly constituted of solids immersed in fluids in relative motion. The

simulator is composed of three principal sub-assemblies: An RC lattice representing the solid body, a group of resistances varying automatically as a function of non-linear conditions at the limits, and a simulator-device of the movement and physical properties of the fluid. The design problem was formulated. The logical scheme of the simulator is given. The construction is at the stage of definitive technological preparation of the simulation system of the flow and of the variable resistance. (J.S.R.)

36500 MODEL FOR SIMULATION OF A FORCED CIRCULATION HEAT EXCHANGER. Bona, C.; d'Hoop, H. (CCR–EURATOM, Ispra, Italy). pp 157-9 of Analog and Hybrid Computation Applied to Nuclear Energy. Brussels, Presses Academiques Europeennes (1969). (In French).

From International Symposium on Analogue and Hybrid Computation Applied to Nuclear Energy, Versailles, France. See CONF-680941.

A classical analog method for the simulation of a forced circulation heat exchanger was developed based on the integration in time and the elimination of space variables. The development of the method was caused by the non-availability of hybrid material. Its principal advantage is the simplicity of the programming and of the necessary calculation instrument. The calculation of the boundaries of state exchange was illustrated. The temperature profiles were calculated. The results obtained were compared with values calculated by other methods and the agreement is satisfactory. (J.S.R.)

36501 SIMULATION OF INCIDENTS IN HOT SODIUM VAPOR GENERATORS BY MEANS OF ANALOG CALCULATORS (CARES PROGRAM). Trimouille, C.; Cambe, H. (CEN, Cadarache, France). pp 160-75 of Analog and Hybrid Computation Applied to Nuclear Energy. Brussels, Presses Academiques Europeennes (1969). (In French).

From International Symposium on Analogue and Hybrid Computation Applied to Nuclear Energy, Versailles, France. See CONF-680941.

A mathematical model was formulated for the simulation of incidents in sodium-heated steam generators. The model was applied to various types of steam generators. The characteristics of the sodium-heated generators of the Phenix reactor were defined from the mathematical model. An incident study on the reference circuit of the Phenix reactor was described. (J.S.R.)

Isotope Technology

Refer also to abstracts 36208, 36456, 36537, 36591, 36598, 36794, 36859, 36894, and 36948.

36502 (AI-AEC-12962) LARGE RADIOISOTOPE HEAT SOURCE CAPSULE PROGRAM. TOPICAL REPORT NO. 9, TRANSIT CAPSULE THERMAL VERIFICATION TESTS. (Atomics International, Canoga Park, Calif.). 29 May 1970. Contract AT(29-2)-2338. 87p. Dep. CFSTI.

The fabrication and assembly history, and the test results for the Transit Thermal Verification Capsule are presented. The thermal verification capsule is an electrically heated mockup from which data were obtained on thermal gradients around individual components and on the ΔT's between components. Tests were accomplished in both helium and vacuum environments. (auth)

36503 (DP-1237) SAVANNAH RIVER LABORATORY ^{60}Co POWER AND HEAT SOURCES. Quarterly Progress Report, January–March 1970. Angerman, C. L.; Ross, C. P. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). May 1970. Contract AT(07-2)-1. 15p. Dep. CFSTI.

Research and development activities are summarized. Investigations resulted in improved welds made in arc-cast tungsten capsules by increasing weld speed and providing additional cooling to the cap being welded. Wafers of cobalt oxide (CoO) at 90% of theoretical density were fabricated by an improved sintering process. High-melting cobalt compounds were found to be not compatible with tungsten and TZM at 1600°C. Radiation streaming from coolant ducts will not be limiting in the WANL 30 kW(t) ^{60}Co heat source. (auth)

36504 (EANDC-84(U)) ISOTOPE SEPARATION FACILITIES. (European-American Nuclear Data Committee). May 1970. 57p. Dep. CFSTI (U. S. Sales Only).

The general and special specifications of isotope separation facilities in Europe, Japan, and the US are presented, based on information available in May 1970. The general specifications include: location, dates for design, construction, and operation, purpose, scientist in charge, and present and future operations. Specifications are included for the ion source, tube, magnet, collector, and vacuum equipment at each facility. (L.C.L.)

36505 (MDC G-1689) PLUTONIA/CURIA COMPATIBILITY TESTING. Quarterly Report No. 6, January–March 1970. Andelin, R. L.; Watrous, J. D. (McDonnell Douglas Astronautics Co., Richland, Wash. Donald W. Douglas Labs.). Apr 1970. Contract AT-(45-1)-2138. 19p. Dep. CFSTI.

Comparative compatibility test results indicate that relatively pure plutonia-238 is somewhat less reactive with alloys of molybdenum, tungsten, and rhenium than is a less pure form of plutonia-238 after exposure at 1800°C for 2000 hours. Oxygen loss through molybdenum alloy container walls was the same for both fuel forms. Metallic precipitation in the plutonia appears to be a function of purity level. Six refractory metal capsules containing curia-244 completed exposure at 2000°C for 1000 hours. Six capsules are being exposed at 1800°C for 5000 hours and six more capsules are ready for exposure at 2000°C for 5000 hours. A plutonia-molybdenum cermet exposed at 1800°C for 1000 hours in a closed container was relatively undamaged. A similar cermet exposed at 2000°C for 1000 hours was damaged extensively. (auth)

36506 (MMM-3824-46) SNAP-23A PROGRAM, PHASES 1 AND 2, THERMOELECTRIC CONVERTER DEVELOPMENT PROGRAM. Quarterly Report No. 13, January 1, 1970–March 31, 1970. (Minnesota Mining and Mfg. Co., St. Paul. Electrical Products Group). 30 Apr 1970. Contract AT(30-1)-3824. 162p. Dep. CFSTI.

The Prototype Mockup Converter No. 2 (PMC-2) completed the 500 hour test program and was installed on the Fueled Prototype Mockup System (FPMS). Fabrication and assembly of PMC-3 was completed. The converter was placed on test and completed the stability conditioning phase of the test. The failure analysis of PMC-1b and PMC-2 converters was completed. The failure of PMC-1b was due to reaction between the thermoelectric leg material and copper from the hot junction electrode. This reaction was caused by sulfur under the iron plating on the electrodes causing a void in the plating through which a copper nodule could grow. The PMC-2 failure was traced to an inverted P leg. Other activities such as performance analysis of PMC-2, design of PMC-3, design of plan for mating converters to isotopic heat sources, and continued test operation of thermoelectric devices are summarized. (J.R.D.)

36507 (ORNL-4567) ORNL ISOTOPIC POWER FUELS QUARTERLY REPORT FOR PERIOD ENDING MARCH 31, 1970. Lamb, Eugene (Oak Ridge National Lab., Tenn.). Jun 1970. Contract W-7405-eng-26. 20p. Dep. CFSTI.

Equipment for the Curium Source Test was assembled and installed in the test cell. The source capsule was fueled with 956 W(th) $^{244}Cm_2O_3$ contained in fourteen pellets. The exposure runs of five sets of compatibility couples were completed. The 1850°C exposure series was completed. Experiments are in progress to measure the rate of transfer of Cm_2O_3 by volatilization and diffusion in a helium atmosphere. The adiabatic calorimeter for the determination of the heat capacity and stored energy in $^{244}Cm_2O_3$ has been fabricated and is being assembled. Compatibility couples of $^{90}SrTiO_3$ are being exposed to 900 and 1100°C temperatures to investigate the effect of method of preparation on the compatibility of $^{90}SrTiO_3$. (auth)

36508 (ORNL-TM-3011) ISOTOPE KILOWATT PROGRAM QUARTERLY PROGRESS REPORT FOR PERIOD ENDING MARCH 31, 1970. (Oak Ridge National Lab., Tenn.). Jul 1970. Contract W-7405-eng-26. 56p. Dep. CFSTI.

The first step in attempting to evolve a reference design for an organic Rankine cycle system was to review the information available on the various organic working fluids and the experience at various operating temperatures. The design study has been directed toward the use of Dowtherm A at a temperature of about 600°F where thermal degradation should not be serious, even for periods of as much as five years. The various organic Rankine cycle power plant configurations were considered and a better configuration was incorporated in the reference design to give important advantages with respect to control of the liquid inventory while at the same time reducing the overall size of the power unit. It appears that both the cost of fabricating the isotope capsules and the size and weight of the heat block-shield assembly can be reduced by increasing the diameter of the fuel capsules and increasing their length. A heat block-shield design with a cluster of 7 capsules was developed. Materials considerations, particularly the 10 meter drop test, have led to the choice of low carbon iron as the heat block-shield material. A heat block-shield assembly has been evolved that will satisfy not only the requirements of the organic Rankine cycle system, but also those of the steam Rankine cycle and thermoelectric systems. Thermal insulation is being considered for achievement of a good thermal barrier at normal operating temperatures and yet melt out if the

temperature increased by 200°F above the design temperature. The use of a large number of layers of aluminum wire screen, has been investigated. Analyses indicate that it should satisfy both the thermal insulation and thermal fuse requirements. The principal problems other than the turbine generator associated with the steam Rankine cycle appear to be those of system control and the detailed performance characteristics of the re-entry tube boiler. A new reference design for a complete power unit employing a set of thermoelectric modules and heat pipes has been worked out and is now under critical review. It is expected that this design will serve as the reference design for the Phase II effort. (J.R.D.)

36509 (SC-PR-70-222) AEROSPACE NUCLEAR SAFETY PROGRAM. Quarterly Report, January 1–March 31, 1970. Clark, A. J. Jr. (Sandia Labs., Albuquerque, N. Mex.). Apr 1970. 51p. Dep. CFSTI.

Impact tests and postmortems of the TRANSIT heat source were completed. A Task 8 heat source was exposed to simulated reentry conditions and the heat shield wall ablated through in the stagnation line area about 30 seconds after the point of peak heating rate. The temperature and velocity of a modified Pioneer heat source at earth impact were determined. Alpha particles were thermalized in a band approximately 9 μm from the surface of Mo foil. Helium bubbles precipitated in the region of the alpha band after the sample was aged and annealed. Scaling laws were developed for fuel capsules subjected to blast loading fragment impact, and earth impact. (J.C.W.)

36510 (SC-RR-70-301) FEASIBILITY OF THERMORADIATION STERILIZATION OF SPACECRAFT USING ^{60}Co. Jefferson, R. M. (Sandia Labs., Albuquerque, N. Mex.). May 1970. 35p. Dep. CFSTI.

The feasibility of utilizing thermoradiation sterilization for planetary quarantine of spacecraft depends in part upon the ability to find a source capable of providing a reasonably uniform gamma exposure throughout the vehicle at a rate of about 10^4 R/hr. Early proposals to use the fission product decay gammas from a nuclear reactor fuel system did not provide the needed uniformity although the rate was sufficient. Other suggested sources included cobalt-60 and a 10 MeV accelerator. This report investigates the use of cobalt-60 as a source. By simple arrangement of the cobalt into line sources and by selectively placing these sources in relation to the spacecraft, it is possible to provide a uniform dose of 10^4 R/hr to a typical spacecraft. Suggestions and cost estimates are included for a minimum facility in which to perform such an exposure. (auth)

36511 ISOTOPE TECHNIQUES IN THE TEXTILE INDUSTRY. Vogg, Hubert (Gesellschaft fuer Kernforschung mbH, Karlsruhe, Ger.). Melliand Textilber.; 11: 1361-5(1969). (In German). (KFK-1089).

Various possibilities for utilizing isotopes in the textile industry are discussed. Sealed radiation sources are used for thickness measurements of ribbons, measurement of layer thickness, and determination of density variation in textile material. Open application of radioactive material is utilized to measure homogeneity of mixtures, equality of color impregnation, and distribution of catalysts. Non-radioactive elements are used to determine certain components in textile mixtures. As an example, lanthanum is added to polyester; the yarn, consisting of polyethylene cotton, is then activated by a neutron source. Induced radioactivity of the lanthanum consequently indicates polyester distribution in the yarn. Neutron activation analysis plays an important role in the determination of trace elements in textile material from which, in turn, judgments about origin and quality can be made. (H.B.G.)

36512 RADIOACTIVE ISOTOPES IN AUTOMATIC INDUSTRIAL CONTROL. Jannarelli, R.; Pepe, L. Com. Naz. Energ. Nucl., Notiz., 15: No. 8-9, 104-9(Aug.-Sept. 1969). (In Italian).

The areas of application of radioisotopes in industry are summarized. Nuclear instrumentation based on radiation absorption and radiation scattering is described. The factors affecting the selection of the source are considered. The characteristics of detectors were examined from the viewpoint of measurement sensitivity, linearity of response, and interval of measurable intensity. Two examples are given of the industrial use of radioisotopes: level control in continuous operation in the petroleum industry; and control of the percent of sulfur present in mineral oils. (J.S.R.)

36513 SEPARATION OF XENON ISOTOPES IN THE THERMAL DIFFUSION COLUMN. Roos, W. J.; Rutherford, W. M. (Mound Lab., Miamisburg, Ohio). J. Chem. Phys.; 52: 1684-7 (15 Feb 1970).

Thermal diffusion column coefficients were measured for the separation of the isotopes of natural xenon, a mixture of nine stable species, in a 7.32-m hot wire column at wire temperatures of 790 and 1073°K. For the two remixing coefficients good agreement was found between experiment and the theory of the thermal diffusion column. Measured values of the initial transport coefficient, however, were in poor agreement with theory when the theoretical calculations were based on measurements of the thermal diffusion factor of xenon taken from the literature. The agreement was considerably improved by the use in the theory of isotopic thermal diffusion factors evaluated from a corresponding states correlation of data for other noble gases. On this basis the average ratio of the experimental initial transport coefficient to the corresponding theoretical value was found to be 1.10 ± 0.07. (auth)

36514 ISOTOPE GENERATORS: A REVIEW OF THE PRESENT STATE OF DEVELOPMENT. Bernhard, Horst; Lieser, Karl Heinrich (Technische Hochschule, Darmstadt, Ger.). Euro-Spectra; 9: 20-4(Mar 1970).

Nuclear reactors and accelerators make a large number of radionuclides available. An isotope generator contains a relatively long-lived parent nuclide which is fixed on a carrier and whose chemical form allows the rapid, simple, and repeated separation of the daughter nuclide with the desired short half-life nuclide, produced as a result of radioactive decay. The requirements for medical, industrial, and laboratory use of isotope generators, known as nuclear cows, are listed. The parent-daughter systems applicable in isotope generators are tabulated. An advantage of the isotope generator is the large amount of activity that is made available by repeated milkings of the cow, especially of interest to the medical profession. Tendencies in the further development of milking systems are towards the use of long-lived parents which is profitable even when milking is performed at irregular intervals. The design of the isotope generator must allow for contamination-free daughter nuclides. A mathematical description of the parent-daughter system is given. (J.C.W.)

36515 THERMAL DIFFUSION OF ARGON ISOTOPES. Tokuda, Taneki; Ando, Yasumasa; Fukui, Katsunori (Tokyo Metropolitan Univ.). J. Appl. Phys.; 41: 2854-9(Jun 1970).

The optimum conditions in operating a thermal diffusion column were searched using argon gas. The results obtained were compared with the theoretical values. Two molecular models used for the comparison with the experimental results were the inverse power model and the Lennard–Jones potential model. The former showed a little better agreement with our results than the latter. When P^4 was plotted as abscissa and $P^2/\ln q$ as ordinate, the relation $P^2/\ln q = (1/a)(P^4 + b)$ gave a straight line. Substituting the experimental results in this equation, the time-course variation of the values 1/a and b/a from the slope and intercept of these linear plots was obtained. The variation of a and b with time was useful as a clue to see if the system was in equilibrium or not. Minimum values were observed near the optimum pressure in each operating time. Theoretical calculation of the relaxation t_r which characterized the approach to equilibrium was 1.04 hr. Employment of direct current to heat the wire was a little better than the alternating current. (auth)

36516 DIFFICULTIES IN INTERNATIONAL COOPERATION ON URANIUM ISOTOPIC SEPARATION. Com. Naz. Energ. Nucl., Notiz.; 16: No. 5, 78-85(May 1970). (In Italian).

The full text of an article outlining the history of the attempts made, from the earliest days of the nuclear era to the present, in the area of international cooperation on the isotopic separation of uranium is presented. (auth)

36517 RADIOAKTIV IZOTOPOK A TUDOMANYOS KUTATASBAN, SZIMPOZIUM, BUDAPEST, 1969 NOVEMBER 12–13. (Radioisotopes in Scientific Research. Symposium, Budapest, November 12–13, 1969). Atomtech. Tajek.; 13: 1-100(1970). (CONF-691121).

Abstracts of papers presented at the subject symposium are given. Two of the papers read during the plenary session of the symposium are printed in somewhat abbreviated form; they are: "Use of radioactive isotopes for the study of the active transport of living cells" by E. Broda (Institute of Physical Chemistry, Section of Radiation Chemistry of the University of Vienna), and "Effect of radiation on the heterogeneous equilibrium in the solid-solution system" by Spitsyn, V. I.; Torchenkova, E. A.; Glazkova, I. N. (Lomonosov State University, Moscow). The other 114 abstracts refer to papers presented in four sections: I. Physiochemical phenomena; II. Biochemical studies; III. Tracer techniques in metallurgical and other industrial applications; IV. Agricultural research using radioactive isotopes. (TTT)

36518 SEPARATION OF ARGON ISOTOPE BY HOT WIRE THERMAL DIFFUSION COLUMN. Kanagawa, Akira; Kimura, Syojiro (Kyoto Univ.). Nippon Genshiryoku Gakkaishi; 12: 306-10(1970). (In Japanese).

Experimental studies on isotope separation of natural Ar were carried out using a 1.0-m-long hot-wire diffusion column made of glass. The effect on the separation performance of the column due to the presence of spacers for centering the hot wire was studied by changing the number of spacers. The separation factors obtained experimentally in the column without spacer were markedly low compared with the theoretical values calculated on the basis of the Lennard-Jones potential model. With spacers present, the separation factor was found to increase with the number of spacers until a maximum was reached at 7 spacers, beyond which the separation factor tended to decrease again. Results of experiments carried out with spacers arranged for eccentric placement of the hot wire in the column indicated that improvements in separation performance could be expected mainly from better centering of the hot wire, and that disturbance of the gas flow by the spacers should not significantly affect separation. (auth)

36519 UNIFORM γ DISC SOURCE USING SHORT LIVED ISOTOPES. Bishop, G. B.; Cleaver, J. W. (Univ. of Liverpool). J. Nucl. Energy; 24: 143-9(Jun 1970).

A disc radiator having uniform gamma source strength per unit surface area was designed and tested. Measured source strength distributions using the short lived isotope ^{20}F showed that the source strength was constant to within about ±10%. The design method can be used for other short lived isotopes such as ^{16}N in order to produce uniform gamma radiators emitting high energy photons. (auth) (UK)

36520 SEPARATION OF A BINARY GAS MIXTURE THROUGH CENTRIFUGATION: EXPLANATION OF THE AXIAL ENRICHMENT OBTAINED IN ULTRACENTRIFUGES. Guilloud, J. C. (Univ., Grenoble, France). Compt. Rend., Ser. A; 270: 963-6 (13 Apr 1970). (In French).

One of the interesting points of the ultracentrifuge in the field of isotopic separation is due to the fact that by creating an appropriate axial convection movement inside the rotor, the enrichment obtained between the two extremities is greater than radial enrichment. It is shown, by means of a simple diagram, why a transversal separation effect inside a mixture can be amplified axially by its mean movement. (auth) (France)

36521 PREPARATION OF AN IDEAL CALIBRATION SOURCE OF ^{95}Nb BY ELECTRODEPOSITION FROM AN AQUEOUS BATH. Joshi, B. M.; Bhatki, K. S. (Tata Inst. of Fundamental Research, Bombay). Nucl. Instrum. Methods; 83: 226-8(1970).

Niobium-95 is a very useful calibration source in nuclear spectroscopic studies. The procedure developed to electro-deposit this nuclide in a carrier-free form from an aqueous bath employing urea-oxalate as an electrolyte is described. Employing a current density of about 70 mA/cm^{-2}, 80% of the ^{95}Nb activity has been deposited in two hours time. (auth)

36522 SEPARATION NOZZLE PROCESS FOR URANIUM ENRICHMENT. Becker, E. W. Atoomenergie Haar Toepass.; 11: 272-6(Nov 1969).

The separation nozzle process for uranium enrichment is described. The process is based on pressure diffusion in a gaseous mixture of UF_6 and an additional light gas flowing at high speed along curved walls. The principles involved in the separation nozzle process along with results obtained are presented. A cost estimate of a separation nozzle plant is given in which the cost of a separative work unit is $35.00. This is 35% more than the guaranteed U.S. price. However, since the separation nozzle process is comparatively new, it is believed that a program of basic and developmental research will result in a better understanding of the separation mechanism and will result in further economic improvements. (R.C.K.)

36523 ALPHA-PARTICLE-EMITTING RADIOISOTOPE GENERATOR. Keshishian, Vahe (to North American Rockwell Corp.). U. S. Patent 3,515,875. 2 Jun 1970. Filed 17 Jun 1965.

A radioisotope generator is described which incorporates a radiation shield and contains an alpha particle emitting radioisotope associated with components which have a threshold for alpha-neutron reactions greater than the maximum energy of the emitted alpha particles. The neutron shielding is in this way substantially reduced. (J.R.D.)

36524 EFFECTIVE ALPHA ACTIVITY AND SELF-ABSORPTION ALPHA RANGE IN $^{238}PuO_2$ MICROSPHERES. Huffman, Gary N.; Kershner, Carl J. (Mound Lab., Miamisburg, Ohio). Nucl. Appl. Technol.; 9: 434-8(Sep 1970).

The self absorption alpha range for the 5.5 MeV alpha emission in $^{238}PuO_2$ was determined to be 11.7 ± 0.2 μm by measurement of the effective activity on microspherical sources of from 150 to 250 μm diameter. A function was derived and experimentally tested which related the fractional escape of the total alpha emission to the range-radius ratio of the microspherical source. An energy distribution function was also derived for the alpha emission from a microspherical source which agreed quite well with the experimentally determined spectrum above 1 MeV. It is suggested that the derived function provides a more accurate description of the energy region below 1 MeV than the experimental data. (auth)

Materials Testing

Refer also to abstracts 36469, 36858, and 36973.

36525 (BNWL-1373) THERMAL NEUTRON RADIOGRAPHY WITH THE PLUTONIUM RECYCLE CRITICAL FACILITY. Cason, J. L.; Maiwald, K. S.; Lippincott, E. P. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jun 1970. Contract AT(45-1)-1830. 28p. Dep. CFSTI.

The feasibility of using the PRCF (Plutonium Recycle Critical Facility) for thermal neutron radiography was demonstrated. Results included flux measurements and neutron radiographs with both direct and indirect techniques. The PRCF was modified on a temporary basis to provide an internal and external beam of neutrons. Experiments were performed under both conditions which proved the feasibility of producing high quality neutron radiographs of various samples and test pieces. Recommendations and conclusions regarding possible approaches for permanent modification of PRCF are presented. (auth)

36526 (CEA-CONF-1539) ULTRASONIC AUTOMATIC TESTING OF AUSTENITIC STAINLESS STEEL WELDS. Marini, J. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1970. 16p. (In French). (CONF-700613-3). Dep. CFSTI (U. S. Sales Only).

From 6th International Conference on Non-Destructive Testing, Hannover, Germany.

An electronic echo selection device as well as a special recorder allowing clear representation of defects were designed and set up. Such devices were successfully used for testing circular as well as linear assemblies. To get better test precision, special focused transducers were studied. The resolution increased greatly with this type of probe and the ultrasonic energy reflected by a defect is so great that a large level of amplification is not necessary. The drawbacks caused by ultrasonic attenuation and electronic noise are eliminated therefore. (auth) (France)

36527 (EUR-4457) DETERMINATION OF TRANSVERSE STRENGTH OF FINNED TUBES. COMPARISON OF EXPLOSION TEST AND RING TEST. Boerman, D. J.; Veaux, M. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). 25 Nov 1969. 28p. (In French). Dep. CFSTI (U. S. Sales Only).

In advanced technology, finned tubes are more and more widely used. In the nuclear field, particularly, they are often used as sheath tubes for fuel elements. These tubes are ordinarily stressed by internal hydrostatic pressure and consequently, the determination of transverse properties is of great interest. Up to now, high temperature burst tests were used for acceptance. This method was too elaborate and time-consuming. The ring test was developed in place of the burst test. The stress patterns in the two cases have been determined on photoelastic models and these results have been confirmed by those obtained by mechanical testing (tensile tests, burst tests, ring tests). The ring test is an excellent technological test. Nevertheless, it gives only relative values, and must previously be compared with classical methods for each type of material and particular shape of tube. (auth)

36528 (NP-tr-1900) DEVELOPMENT OF NEUTRON RADIOGRAPHY WITHIN THE CEA. Boutaine, J. L. Translated by W. G. Stripp (Atomic Energy Research Establishment, Harwell, Eng.), from Bull. Inform. Sci. Tech. (Paris); No. 136, 35-44(1969). 15p. Dep. CFSTI (U. S. Sales Only).

An abstract of this paper, prepared from the original language, appeared as NSA 23: 33346.

36529 (ORNL-4520, pp 173-4) NONDESTRUCTIVE TESTING TECHNIQUES FOR LMFBR. (Oak Ridge National Lab., Tenn.).

From Fuels and materials development program quarterly progress report for period ending December 31, 1969.

New methods, techniques, and equipment for nondestructively evaluating materials for liquid-metal-cooled fast breeder reactors (LMFBR) are being developed with emphasis on measuring cold work in stainless steel tubing. An eddy-current instrument is being

developed to measure both size and depth of defects. A Hg model is used as an aid to the design studies. Several stainless steel welds that contain intentional flaws were prepared for use with the schlieren system. Because of the good results obtained by measuring permeability caused by cold working stainless steel sheet, a prototype system for tubing was designed. Using mathematical models, the optimum design parameters were determined by computer calculations. The results indicate that the relative permeability can be measured to within ±50 ppM, which corresponds to less than 1% change in cold work. (auth)

36530 (ORNL–4520, pp 308–14) NONDESTRUCTIVE TESTING. (Oak Ridge National Lab., Tenn.).

From Fuels and materials development program quarterly progress report for period ending December 31, 1969.

Newly developed computer programs now allow instrument simulation to determine the effect of instrument instabilities on test results. Other new programs now provide construction details for desired eddy-current coils. Techniques were developed for recording on motion picture film sequences in ultrasonic schlieren systems. Experimental and mathematical studies on frequency analysis of ultrasonic spectra demonstrated the feasibility of measuring flaw size by means of spectral variations despite changes in signal amplitude due to differences in acoustic impedance or other variables. Studies in x-ray attenuation demonstrated the ability to measure physical density in graphite with an accuracy of better than 0.5%. The study of scattered and fluorescent radiation for measurement of cladding thickness is continuing on Pb and Al specimens. An improved goniometer is now being used. (auth)

36531 (Y–1731) TORSION TESTING USING A DIGITAL COMPUTER. Poore, M. W.; Smith, J. H. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). 17 Jul 1970. Contract W-7405-eng-26. 36p. Dep. CFSTI.

A digital computer can be used for acquiring and reducing data on torsion tests. The torque and strain signals are fed through an analog-digital converter to a small processor computer where the data are stored, assembled, and reduced. A printout and punched tape are obtained which contain the shear properties and the associated stress-strain data points. (auth)

36532 MEASUREMENT AND CONTROL OF THICKNESS BY THE COMBINED EFFECT OF ABSORPTION AND BACKSCATTERING OF BETA RAYS. Das, S. K.; Pal, K. N. (Fertilizer Corp. of India Ltd., Bihar). Technology (Sindri); 6: 83-7(Apr-Jun-Jul-Sep 1969).

An efficient method was developed for measuring and controlling the thickness of thin sheets of any material utilizing the combined effect of absorption and backscattering of beta particles emitted from a $^{90}Sr/^{90}Y$ source. It was shown that the resolving power of the process was higher than that obtainable by the earlier methods based on individual effects of absorption or backscattering of beta particles. This paper also describes the adjustment of several parameters to suit the particular range and sensitivity requirements. (auth)

36533 STRESS DISTRIBUTION IN AN ARBITRARILY LOADED NOZZLE-TO-FLAT PLATE CONNECTION. van Campen, D. H. (Univ. of Tech., Delft, Netherlands). Nucl. Eng. Design; 11: 495-516(Apr 1970).

A finite element computation method has been developed whereby both mechanical and thermal stresses in arbitrarily loaded nozzle-to-flat plate connections can be determined. The general solution for the displacements is supposed to be a series solution. As a consequence a triangular ring element is developed with a non-axisymmetric strain distribution varying linearly over the cross-section. The proposed method is intended for determining the peak stresses at nozzle-to-cylinder intersections for sufficiently small d/D ratios (typically $d/D \leq \frac{1}{4}$). (auth)

Radioactive Material Handling

Refer also to abstracts 36336, 36343, 36453, 36474, 36855, and 36996.

36534 (ARH–1709) OPPORTUNITY FOR SURVIVAL. A LOOK AT NUCLEAR MATERIAL SAFEGUARDS. Colvin, C. A. (Atlantic Richfield Hanford Co., Richland, Wash.). 19 May 1970. Contract AT(45-1)-2130. 24p. Dep. CFSTI.

Measures being developed to prevent the diversion of nuclear material from uses permitted by law or treaty are summarized. Information is included on international nuclear safeguards, the U3 program, results of special studies, transportation, security, accountability, and laboratories. (J.R.D.)

36535 (BNWL–1357) DESCRIPTION OF THE COMPUTER PROGRAM FOR THE SAFEGUARDS MATERIAL BALANCE SIMULATOR. Johnston, J. W.; Engel, R. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). May 1970. Contract AT(45-1)-1830. 165p. Dep. CFSTI.

A computer program designed to simulate the flow and measurement of nuclear material in the material balance accounting phase of safeguards is described. The structure and uses of the Safeguards Material Balance Simulator (SMBS) are described. Detailed descriptions are also included on input data requirements, calculational formulas and output formats, the computer hardware and software presently used by Battelle-Northwest, and the computer logic used for handling mixed data types. Data for test cases are also included to exemplify how the SMBS is used. The examples from the test cases are explained in detail. (auth)

36536 (CONF–700207(and Add.)) SOUTHERN GOVERNORS CONFERENCE ON TRANSPORTATION OF NUCLEAR SPENT FUEL, ATLANTA, GEORGIA, FEBRUARY 5–6, 1970. (Southern Interstate Nuclear Board, Atlanta, Ga.). 175p. Dep. CFSTI.

Aspects of spent fuel handling and shipping are examined relative to their effects on the nuclear fuel cycle industries of the southern region. Additionally, transportation requirements, container loading, container design, and recommendations of the committee on transportation, are discussed. (J.R.D.)

36537 (JUL–603-ST, pp 139–42) MONITORING OF OPERATIONS: LEAK TESTING. Sauermann, P. F.; Meyer, H. (Kernforschungsanlage, Juelich (West Germany). Zentralabteilung Strahlenschutz). (In German).

About 2,200 curies of radioisotopes were processed, within sealed containers, at KFA Juelich during 1968. Taking $\frac{1}{100}$ of the permissible dose as criterion, no leaks were detected. For instruction purposes, plates contaminated with ^{60}Co and ^{137}Cs were subjected to wiping, brushing, and washing tests. Only 60% of the radioactivity was recovered. Results indicated that leakage of a container with radioisotopes should be assumed when the outside radioactivity surpasses 10^{-3} curie. (H.B.G.)

36538 (ORNL–4451) SITING OF FUEL REPROCESSING PLANTS AND WASTE MANAGEMENT FACILITIES. (Oak Ridge National Lab., Tenn.). Jul 1970. Contract W-7405-eng-26. 415p. Dep. CFSTI.

Results of a study to identify and characterize the factors that may influence the growth patterns of the fuel reprocessing industry are presented. Emphasis is placed on the siting of reprocessing plants and waste storage and disposal facilities, particularly those for high-level waste. A compilation of the key issues under consideration and the principal conclusions of the study are presented. The technical information found in the body of the report relating to these issues and conclusions is summarized. Basic data on reactor and fuel characteristics, projections of spent-fuel processing loads, fuel shipping requirements, and waste characteristics and production are included. Fuel reprocessing is discussed very briefly and waste management technology is considered in significant detail. Cask design as related to safety in transporting spent fuel and solidified waste are discussed. Fuel reprocessing and waste management costs are considered along with environmental and geographical considerations of siting and health and safety aspects. (J.R.D.)

36539 METHOD FOR SUBSURFACE DISPOSAL OF RADIOACTIVE WASTE. Stogner, Joel M. (to Halliburton Co.). U. S. Patent 3,513,100. 19 May 1970. Filed 25 Sep 1967.

A method for disposing of high level, solid, radioactive waste material by delivering such material in a continuous, water-phase cement to a subterranean formation is described. The solid waste was used as a propping agent to hold formation fractures open as a slurry containing the solid, radioactive waste material was pumped into it. (auth)

36540 ITALIAN REGULATIONS ON THE STORAGE OF RADIOACTIVE MATERIALS. Com. Naz. Energ. Nucl., Notiz.; 15: No. 10, 85–9(Oct 1969). (In Italian).

The Italian laws and regulations dealing with the storage of radioactive materials are tabulated and discussed. The tabulation shows the persons or organizations toward whom the law is directed, the activity covered by the law, the regulatory agency concerned, and the penal provisions. (J.S.R.)

36541 DEFORMATION OF ROCK SALT IN OPENINGS MINED FOR THE DISPOSAL OF RADIOACTIVE WASTES. Lomenick, T. F.; Bradshaw, R. L. (Oak Ridge National Lab., Tenn.). Rock Mech.; 1: 5–29(Jul 1969).

With the storage of high-level radioactive waste in salt structures, unique mine stability problems will occur as a result of the elevated temperatures. To predict flow in rock salt, scale models

of salt pillars and their surrounding rooms were fabricated from cores taken in the Carey salt mine, Lyons, Kansas. Tests were conducted at temperatures of 22.5, 60, 100, and 200°C for axial loads of 2000, 4000, 6000, 8000, and 10,000 psi at each temperature. The test results showed that marked increases occur in the rates of deformation of salt pillars at high loads and especially at elevated temperatures. For all combinations of axial loads and temperatures, it was observed that there is initially a high rate of deformation that diminishes with time. Creep rates were found to continue to decrease even after more than 3 years of testing. An empirical relationship between pillar deformation, stress, temperature, and time was developed from the tests. For comparative purposes, model pillar tests were conducted on samples of bedded salt, as well as dome salt from six different mines in the United States and from the anticlinal structure of the Asse II salt mine in Northeast Germany. In general, the deformational behavior for the various types of salt was similar at room temperature as well as at elevated temperature even though some variations in the rates of deformation were observed. From model tests it was also observed that greatly accelerated rates of deformation will occur in excavated cavities where thin shale beds occur in the pillars at the roof and floor interfaces. Since the shales serve as fraction reducers, effective confining stresses in the roof and floor are not transmitted into the pillars; thus the pillars under these conditions are weaker than where shale partings are not present at the tops and bottoms of the pillars. (auth)

36542 GREASELESS MULTIPURPOSE EXTRACTION DEVICE. Hollander, W.; Zanten, B. (Free Univ., Amsterdam). Chem. Ind. (London); No. 23, 742-3(6 Jun 1970).

A multipurpose extraction apparatus designed for use with radioactive material is described. The device can be used for continuous extraction, solvent distillation, sublimation, hydrogenation and other types of reaction. (UK)

36543 USAF NUCLEAR SAFETY, JAN/FEB/MAR 1970, NO. 1, VOLUME 65 (PART 2). SPECIAL EDITION: PROJECT CRESTED ICE. USAF Nucl. Saf.; 65: Pt. 2, No. 1, 1-97(Jan-Mar 1970). (AD-701493; AFRP-122-1).

On January 21, 1968, a B-52 bomber carrying four nuclear weapons crashed on the sea ice off the shore of Thule, Greenland. Both the aircraft and the weapons disintegrated on impact. There was no nuclear explosion since the design of the weapons precluded any nuclear reaction. Nevertheless, limited contamination resulting from the dispersed radioactive material from the weapons had to be controlled and removed, as did the aircraft debris. A major disaster was turned into an example of international cooperation at governmental, scientific, and local levels. During the ensuing months, the Danes and Americans at Thule cooperated in international effort. (USGRDR)

36544 CRITICAL PARAMETERS OF A URANIUM SOLUTION SLAB-CYLINDER SYSTEM. Tuck, Grover; Clark, Harold E. (Dow Chemical Co., Golden, Colo.). Nucl. Sci. Eng.; 40: 407-13 (Jun 1970).

Critical parameters are presented for uranium-solution systems consisting of equally spaced vertical cylinders arranged in a square array resting on the bottom of a 20.3-cm-high square slab tank. Some of these systems were reflected externally. Both the cylinders and the slab contained uranyl nitrate solution having 490 g of uranium (93.2 wt % ^{235}U)/liter. A system of an 87-cm-high array of sixteen 11.0-cm-diam cylinders on an 11.4-cm-thick solution slab was critical. The slab alone was critical at 12.8 cm. Another critical system was a single 22.4-cm-diam cylinder of effectively infinite height on a solution slab 10.8-cm thick. The 22.4-cm diameter is 93.7% of the critical diameter for an infinite cylinder. Monte Carlo calculations, simulating several typical experimental critical systems, yielded values for k_{eff} between 0.958 ± 0.012 and 0.986 ± 0.009. (auth)

36545 TRANSPORT OF DISSOLVED WASTES IN RIVERS. Shull, Roger Don (Federal Water Pollution Control Administration, Washington, D. C.); Gloyna, Earnest F. Contract AT-(11-1)-490. J. Sanit. Eng. Div., Amer. Soc. Civil Eng.; 95: 995-1012 (Dec 1969).

A computer model of a river system was synthesized to demonstrate the possible environmental effects of wastes discharged into rivers in low concentrations over several decades. Transport phenomena principles and data on radioisotope behavior from scale ecological river models and from hydrologic studies on prototype river systems were used. This research was aimed primarily at studying the effects of radioactive wastes. However, the principles developed become immediately applicable to conservative wastes by merely setting the radioactive decay rate equal to zero. Techniques for modeling the transport of radioactive and conservative wastes on long time and long distance bases are demonstrated. (L.C.L.)

36546 HANDLING GRAB. Michot, Gilbert (to Commissariat a l'Energie Atomique). British Patent 1,197,862. 8 Jul 1970. Priority date 15 Feb 1968, France.

The grab orients about its own axis with respect to its positioning arm. It is especially useful in inserting and withdrawing reactor fuel rods and in handling other objects inside the reactor. The grab is capable of automatic re-alignment to engage fuel elements or other objects when their placements require such re-alignment. (J.R.D.)

36547 VACUUM FIXATION OF RADIOACTIVE SLUDGES AND CONCENTRATES IN CONCRETE. Napravnik, Jiri; Verner, Milan (Inst. of Nuclear Research, Rez, Czech). Jad. Energ.; 16: 204-7(Jul 1970). (In Czech).

Radioactive sludges from chemical coagulation and low- or medium-level activity concentrates from evaporators are advantageously fixed in concrete. Different methods based on mixing of dehydrated sludges and concentrates with cement are used. Containers are then filled with the mixture. The results of fixation research are summarized for the case of partial dehydration of concrete components by vacuum exhaustion of the surplus solution before hardening. After hardening of the mixture, very firm concrete blocks are obtained. The method described has been proved in a pilot-plant for the case of the second Czechoslovak nuclear power station. (auth)

Vacuum Engineering

36548 ULTRA-HIGH VACUUM ELECTRON MICROSCOPE SPECIMEN CHAMBER FOR VAPOUR DEPOSITION STUDIES. Valdre, U. (Univ., Bologna); Robinson, E. A.; Pashley, D. W.; Stowell, M. J.; Law, T. J. J. Phys., E (London); 3: 501-6 (Jul 1970).

A differentially pumped specimen stage is described which allows thin film deposition studies to be carried out inside an electron microscope. The pressure in the specimen vicinity can be reduced to about 10 ntorr after 16 hours pumping, and it is shown that meaningful studies of thin film growth of reactive materials are now possible. (auth) (UK)

INSTRUMENTATION

Radiation Detection Instruments

General Detectors and Monitors

Refer also to abstracts 36630, 36632, 36639, 36669, and 36677.

36549 (ACRH-1000-189) WHAT DO CAMERAS SEE. Gottschalk, Alexander (Argonne Cancer Research Hospital, Chicago, Ill. Chicago Univ., Ill. Dept. of Radiology). [Jan 1970]. 16p. (CONF-700110-1). Dep. CFSTI.

From 2nd Annual Meeting of the Nuclear Medicine Seminar, Miami Beach, Fla.

The Anger scintillation gamma camera is described. Various collimator systems, the detection system, resolution, and efficiency are discussed. Also the Anger camera is briefly compared to a radioisotope scanner. (W.H.K.)

36550 (AECL-3566) USE OF MINIATURE ELECTRONICS IN RADIATION PROTECTION. Jones, A. R. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Mar 1970. 22p. (CONF-700505-2). Dep. CFSTI (U. S. Sales Only). AECL $1.00.

From 2nd Congress of the International Radiation Protection Association, Brighton, England.

Examples of miniature electronics techniques which are now being used in instrument design are described including compact packaging of discrete components; digital monolithic circuits using bipolar transistors; digital monolithic circuits using field-effect transistors; linear monolithic circuits which can be designed by the user; solid-state displays using light emitting diodes and digital circuits to control them; and solid-state radiation detectors both with and without internal amplification. The design and performance of three instruments based on these techniques are also described. These include a very high range gamma survey meter using a silicon junction detector as a solid-state ion chamber. The detector is used as a photo-voltaic device and the current generated is amplified by a miniature low power d.c. amplifier. A small alpha monitor using a silicon surface barrier detector and a monolithic pulse amplifier to amplify the pulses produced by the alpha particles is described. Also, a gamma survey meter using an amplifying radiation detector to measure dose rates from 1 mrad/h to 1000 rad/h is discussed. The output is displayed in digital form by light emitting diodes and the digital circuits use field-effect transistors with very small power needs. (auth)

36551 (CEA-N-1328) FAST ANALOG TO DIGITAL CONVERTER. Aveynier, J. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). May 1970. 17p. (In French). Dep. CFSTI (U. S. Sales Only).

A fast analog-to-digital converter is described. This circuit converts positive analog voltages into words of four bits and provides parallel digital output. Time conversion is about 20 nsec. (France)

36552 (DP-Report-109) A LOW-LEVEL MEASUREMENT OF ^{85}Kr. Project DRAGON. Voice, E. H. (Atomic Energy Establishment, Winfrith (England)). Aug 1962. 10p. Dep. CFSTI.

Measurement of gaseous activity down to one disintegration per ten minutes per atmospheric cubic centimeter is described. Details are given of the pressurisable scintillation chamber used, and the dependence of the count rate upon gas pressure and density is examined. (auth)

36553 (ICRU-13) NEUTRON FLUENCE, NEUTRON SPECTRA, AND KERMA. (International Commission on Radiation Units and Measurements, Washington, D. C.). 15 Sep 1969. 57p. ICRU, Washington, D. C. $3.00.

The description and measurement of neutron radiation fields is studied. Neutron fluence and flux density, energy fluence and energy flux density, and kerma and kerma rate are considered. Definitions are presented; measurement techniques and standards are discussed; and ICRU recommendations for further development and a better understanding of neutron measurements are presented. (W.H.K.)

36554 (INSJ-117) WIRE SPARK CHAMBERS IN POLARIZATION MEASUREMENTS OF BREMSSTRAHLUNG. Yoshida, Hajime; Kondo, Kunitaka (Tokyo Univ. (Japan). Dept. of Physics); Kobayashi, Masaaki (Tokyo Univ. (Japan). Inst. for Nuclear Study). 22 Apr 1970. 51p. Dep. CFSTI (U. S. Sales Only).

Wire spark chambers were constructed to measure the angular distribution of electron pairs in the polarization measurement of bremsstrahlung. The wire spark chambers, the high voltage pulser, the read-out system and the operational characteristics of the chambers are described. A wire spark chamber is constructed from a printed wire plane and a pulsed electrode separated by a 6 mm thick lucite frame spacer. The wire plane is made of a 1 mm thick epoxyglass sheet on which strips of copper (1 or 2 mm wide) are etched and gold flashed. The high voltage pulser has EFP60 as the triggering stage, a pulse transformer as the pulse shaper, and a pulse modulator tube 4PR60B as the output stage. The output pulse is 40 nsec in the rise time and 320 nsec in the width. The read-out system consists of ferrite memory cores, the read-out current drivers and their control logics. The operational characteristics, especially the sparking efficiencies, the resolving time, the spark formation time, the spatial resolution, and the gas flow speed effect were studied. Various types of chambers were tested in Neon + 10% Helium and Helium. With the minimum delay time of 130 nsec, the sparking efficiency of 99.2% (97%) is obtained for the WP(226) chamber in Nelium (Helium). Its dependence on the clearing field is more significant for the case of Helium. Half memory time of 300 nsec is obtained at $E_{cl} \gtrsim 100$ V/cm (400 V/cm) for Nelium (Helium). Spark formation time is 80 nsec for the high voltage pulse of 6KV/cm. Spatial resolution is estimated to be typically 0.4 ~ 0.6 mm (0.5 ~ 0.8 mm) for Nelium (Helium). The effect of diffusion of track electrons and that of sweeping-out by the clearing field compete with each other when the delay time becomes longer than the memory time. The increase of the gas flow speed results in a shift of breakdown field in the higher direction and also in a decrease of double events. These results are discussed in terms of the drift velocity of electrons and the electron multiplication. The effect of small impurities in the gas is also discussed leading to a consistent result with the theory. No significant change was found in the operational characteristics of the chambers when the width of a wire (or the spacing between adjacent two wires) is varied from 2 to 1 mm. A small degradation in the local uniformity of the sparking efficiency was observed for the chamber having wire planes on both sides. (auth)

36555 (JUL-603-ST, pp 93-100) ADDITIONAL ACTIVITIES OF THE OFFICE FOR ENVIRONMENTAL MONITORING. Vogt, K. J.; Nordsieck, H. (Kernforschungsanlage, Juelich (West Germany). Zentralabteilung Strahlenschutz). (In German).

Instrumentation for the measurement of α, β, and γ activity in air, soil, and water in the environment of KFA Juelich is described. Five figures demonstrate the differences in both sensitivity and resolution of the γ spectrum obtained either with sodium iodide crystals or germanium (lithium) semiconductors. (H.B.G.)

36556 (JUL-603-ST, pp 191-4) DOSIMETRY FOR PERSONNEL AND LOCATION: INVESTIGATION OF RECOIL TRACKS IN PLASTIC AS A MEANS FOR NEUTRON DOSIMETRY. Heinzelmann, M. (Kernforschungsanlage, Juelich (West Germany). Zentralabteilung Strahlenschutz). (In German).

Foils of triacetic cellulose and polycarbonate were exposed to neutrons from an americium–beryllium source with an average energy of 4.2 MeV. Following irradiation, the foils were etched in 30% potassium hydroxide at 60° and the particle tracks counted under the microscope at four hundred fold magnification. Some of the etching was performed in an ultrasonic bath because this method shortened the time requirement significantly. Differences in the character of tracks between triacetic cellulose foils before etching caused no fading at 80°F. Fading occurred at higher temperatures and its degree depended on the duration of etching. (H.B.G.)

36557 (NP-18282) CALCULATION OF THE SENSITIVITY OF THE X-RAY PHOTODIODE. Diagnostic Memo 7/69. Youel, R. (Atomic Weapons Research Establishment, Aldermaston (England)). 5 Sep 1969. 37p. Dep. CFSTI (U. S. Sales Only).

A set of easily evaluated expressions is derived giving the sensitivity of cathodes of various z to x-rays for the planar and foil geometries. The sensitivity for the shovel geometry is found by the numerical evaluation of an easily coded integral. The results for the primary quantum efficiency Ep are in excellent agreement with the limited number of experimental values available, except for two materials, Sn and Pb. It is possible that there are other factors which become important for Sn and Pb at the energy at which the comparison was made and which were neglected, such as L Auger emission and uncertainty in the photoelectron energy. The values of the photoelectric contribution to Ep calculated here also agree well with calculated values from another source which

used different methods. Comparison of the calculated total quantum efficiencies E_T with experiment, for a range of photon energies, shows that for the three materials studied (Al, Ni, Mo all in planar geometry) the calculated values are consistently less than the experimental values. A possible explanation is the underestimation of the secondary effect. The observed spectral profiles are, however, well reproduced. (W.H.K.)

36558 (PAEC(D)-701) CALIBRATION OF BETA-GAMMA SURVEY METERS. Mateo, Alejandro J. (Philippine Atomic Energy Commission, Manila). Aug 1969. 28p. Dep. CFSTI (U. S. Sales Only).

A method for calibrating a beta-gamma survey meter was attempted using three different standard sources to obtain a more accurate calibration. The following standard sources were used: 47.57 mCi ^{226}Ra; 10 mCi ^{137}Cs, and 11.6 mCi ^{60}Co. The specific γ-ray emission or "K" factors being known from the tables, different distances and theoretical values of radiation doses were calculated. From these values, the efficiencies of the various scale ranges of the meters and their percentage errors were also computed. (auth)

36559 (RFP-1488) ^{239}Pu DETECTION IN VIVO WITH A GERMANIUM-LITHIUM ARRAY. Tyree, William H.; Bistline, Robert W. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). 12 Jun 1970. Contract AT(29-1)-1106. 8p. Dep. CFSTI.

Results are given of simulated in vivo measurements of plutonium-239 amounts detected in the chest (lung) cavities of a water-filled phantom model. The device developed is a germanium-lithium detector array, using the 51.63 kiloelectron-volt gamma ray from plutonium-239. A minimum detectable three-sigma limit of about 4.5 maximum permissible lung burdens was obtained in 4000 seconds. The development of larger germanium-lithium detectors suggests a capability of measuring plutonium deposited in vivo in amounts less than one maximum permissible lung burden. Comparisons are included of some parameters of other detection systems for whole-body counting of low energy emissions (photons). (auth)

36560 (STI/DOC-10/107) NEUTRON FLUENCE MEASUREMENTS. Technical Reports Series No. 107. (International Atomic Energy Agency, Vienna (Austria)). 1970. 193p. IAEA $5.00.

A comprehensive guide for neutron fluence measurements in reactors using activation detectors is presented. The general nature of the overall reactor neutron spectra is discussed, and a general review of the mathematical relationships coupling the thermal, intermediate, and fast components of the spectra is given. The methods associated with the measurement of thermal neutron fluence and the effective temperature of the thermal neutrons are presented. Types of activation detectors unique to the measurement of thermal neutron fluence are described, and associated problems such as flux perturbations and foil handling techniques are discussed. Intermediate neutron fluence measurements are discussed with special attention to sandwich foil techniques for separating resonance activation from that due to neutrons of all energies. A detailed mathematical treatment is included. Also, the theoretical basis and experimental techniques for fast neutron fluence measurements are discussed. Fast neutron data reduction, especially the treatment of those reactions with high burnup cross sections of isomeric states with short half-lives is discussed. (207 references) (W.H.K.)

36561 CHARGE COLLECTION Ge(Li)-DETECTORS IN HIGH MAGNETIC FIELDS. Hammerer, K.; Rauch, H. (Oesterreichische Hochschule, Vienna). Atomkernenergie; 15: 281-4 (1970).

The mechanism of charge collection in semiconductor radiation detectors is altered by an external magnetic field. This leads to a variation of the electron- and hole tracks and therefore the charge carrier mobility decreases. This results in a deterioration of the charge collection efficiency η and an increase of the pulse rise-times. A Ge(Li)-detector was examined in the field of a superconducting magnet at field strengths up to 50 kOe and at various detector bias voltages. The influence on the distribution of energy and pulse rise-times was measured. (auth)

36562 POSSIBILITY OF MEASURING LOW ALPHA ACTIVITIES USING A WIRE-PLANE SPARK COUNTER. Saro, S. (Komensky Univ., Bratislava). Physica; 8: 25-45(1969). (In Slovak).

The possibility of using a wire-plane spark counter with air filling at atmospheric pressure for precise measurement of low alpha activities in the presence of other types of radiation has been investigated. For this purpose some important properties of such a counter were examined. A moderate dependence has been found of the counter efficiency on the concentration of water vapor in air. Maximum efficiency has been found at a relative humidity of 50 to 70%. The width of the sensitive region of the counter does not depend very much on the anode wire diameter. A change in wire diameter from 0.03 to 2 mm changes the width of the sensitive region by a factor of two. A strong directional dependence of the counter efficiency has been found for all electrode configurations. Spark counters can be used for precise determination of low alpha activities only for samples which differ from the alpha standard only by their activity. (NSA of Czech.)

36563 IDENTIFICATION OF CHARGED PARTICLES BY COMBINATION OF THE MAGNETIC ANALYSIS AND THE ΔE, E METHOD. Artukh, A. G.; Avdeichikov, V. V.; Eroe, J.; Gridnev, G. F.; Mikheev, V. L.; Volkov, V. V. (Joint Inst. for Nuclear Research, Dubna, USSR). Nucl. Instrum. Methods; 83: 72-6(1970).

A new method for detecting nuclear reaction products with $Z \lesssim 10$ is described where the combination of the magnetic analysis and the ΔE, E method has been applied. The use of a telescope consisting of thin and thick detectors in the output focus of the magnetic analyzer eliminates the ambiguity of particle identification with magnetic analyzer due to various charge states and improves the mass resolution of the ΔE, E method. (auth)

36564 LOW-LEVEL-COUNTING OF POSITRON EMITTERS. Roedel, W. (Univ., Heidelberg). Nucl. Instrum. Methods; 83: 88-92(1970).

A γ-γ coincidence detector with good efficiency at moderate costs for cosmogenic positron emitters (like ^{22}Na and ^{26}Al) is described. The influences of different operation modes on sensitivity and background are discussed. (auth)

36565 MULTIDETECTOR SYSTEM FOR NEUTRON SMALL-ANGLE SCATTERING-EXPERIMENTS. Abend, K.; Schmatz, W.; Schelten, J.; Mueller, K. D. (Kernforschungsanlage, Juelich, Ger.). Nucl. Instrum. Methods; 83: 111-14(1970).

A two diminsional position-sensitive multidetector system for neutrons based on the use of proportional counters with resistance wire is described. Spatial resolution of 0.81 cm fwhm at statistical counting rates up to 50 kHz have been obtained. Data collection and experiment control are performed on-line with a PDP-8-computer. (auth)

36566 A NEW TIME-OF-FLIGHT PARTICLE DETECTOR. Muga, M. L.; Burnsed, D. J.; Steeger, W. E.; Taylor, H. E. (Univ. of Florida, Gainesville). Nucl. Instrum. Methods; 83: 135-8(1970).

A new charged particle detector is described that is capable of registering the passage of very heavy ions (e.g., fission fragments) with only a few percent energy loss. The detector consists of a thin scintillator film placed perpendicular to the face of a photomultiplier tube and sandwiched between two lucite light guide enclosures which are coupled optically to the photomultiplier tube. The signal to background noise ratio and signal pulse rise times are quite adequate for use in time-of-flight measurements of heavy charged fragments. (auth)

36567 ON THE PRECISION TIMING OF PULSES, AVOIDING ERRORS DUE TO DEAD TIMES OR GATE OPENING. Cova, S.; Bertolaccini, M. (Politecnico, Milan). Nucl. Instrum. Methods; 83: 133-4(1970).

In the timing of pulses, inhibition of the timing circuit during some time intervals (dead time effects, gating, etc.), causes an error when the inhibition end falls during a pulse. This error is considered and a way to avoid it is discussed. Experimental results are shown and possible applications suggested. (auth)

36568 PULSE-SHAPE DISCRIMINATION WITH SURFACE BARRIER DETECTORS. Emmerich, W. D. (Univ., Erlangen, Ger.); Frank, K.; Hofmann, A.; Dittner, A.; Klein, J. W.; Stock, R. Nucl. Instrum. Methods; 83: 131-2(1970).

Using the influence of the particle range on pulse rise time we set up an experimental arrangement, which allows the discrimination of protons and alpha particles above 5 MeV. (auth)

36569 SCINTILLATION COUNTING WITH A FLUORESCENCE RADIATION CONVERTER. Keil, G. (Technische Hochschule, Munich). Nucl. Instrum. Methods; 83: 145-7(1970).

A fluorescence radiation converter with a scintillator input stage is described. The unit consists of a blue-emitting NE 102 A plastic scintillator plate which is optically connected with a green-fluorescing acrylic glass rod. The green light output is measured by a small-area photomultiplier. Alpha-, beta- and gamma-spectra obtained with the converter system are presented. Irradiations at various points of the scintillator stage caused only minor changes in output signal amplitude. Using the described detection principle, highly compact low-cost particle detectors with large sensitive areas could be constructed. (auth)

36570 RECTIFIED ac DRIFTING OF GERMANIUM DETECTORS. DeWit, R. C. (Bell Telephone Labs., Inc., Murray Hill, N. J.); McKenzie, J. M. Nucl. Instrum. Methods; 83: 142-4(1970).

The technique of drifting the lithium in a rectified ac field during fabrication of lithium drifted detectors is described. The resultant time dependent current waveforms when interpreted are used to monitor the drift. (auth)

36571 RADIOMETRIC INSTRUMENTATION AND TECHNIQUES AT ELDORADO'S BEAVERLODGE OPERATION. Peebles, G. A. (Eldorado Nuclear Ltd., Saskatchewan). Trans. Can. Inst. Mining Met.; 72 311-16(1969).

The various types of radiometric instruments and the techniques of their operation for grade control, sampling, assaying and probing drill holes at Eldorado Nuclear's uranium mine in northern Saskatchewan are described. Modifications that have been made to these instruments are discussed, and suggestions are made for the development of more refined and specialized radiometric equipment. (auth) (Canada)

36572 A LIGHT GUIDE DESIGN FOR UNIFORM SENSITIVITY OVER A LARGE DIAMETER SCINTILLATOR COUPLED TO A SINGLE PHOTOMULTIPLIER. Galloway, R. B.; Vass, D. G. (Univ. of Edinburgh). Nucl. Instrum. Methods; 83: 35-8(1970).

A 305 mm diameter plastic scintillator was tested for uniformity of response to γ-rays, without loss of detection efficiency, when coupled by alternative conical light guides to a 115 mm diameter photomultiplier. The successful system was further tested for uniformity of neutron detection in a liquid scintillator with pulse shape discrimination against γ-rays. (auth)

36573 A GATED INTEGRATOR FOR Ge(Li) DETECTORS. Rasmussen, V. K. (Franklin Inst., Swarthmore, Pa.). Nucl. Instrum. Methods; 83: 39-44(1970).

It is shown that losses due to high counting rates in a Ge(Li) or other semiconductor detector system may be reduced by a factor of 2 or 3 with tolerable degradation in resolution and that delay line pulse shaping is promising for such detectors. (auth)

36574 SIMPLE TECHNIQUE FOR PRECISE DETERMINATIONS OF COUNTING LOSSES IN NUCLEAR PULSE PROCESSING SYSTEMS. Bolotin, H. H.; Strauss, M. G.; McClure, D. A. (Argonne National Lab., Ill.). Nucl. Instrum. Methods; 83: 1-12(1970).

A new technique has been developed to determine precisely the fraction of all counting losses suffered in counting and pulse height analysis systems. Of particular significance is the applicability of this method to time-dependent counting rates. The method is based on a technique in which the rate of radiation incident upon the detector is sampled continually. Upon the detection of a preset number of counts, a pulser signal is injected into the preamplifier. At the end of the experiment, the total number of injected pulses is compared with the number of these pulses that are recorded in the multichannel analyzer or scaler. Since the pulser peak suffers the same fractional losses as the spectral components of the detected nuclear events, such a comparison provides an accurate representation of the counting losses due to all loss-producing effects. These include losses incurred in ADCs, computers, pileup rejectors, etc. Losses suffered due to pileup may not be negligible compared with those due to the ADC and memory of fast multichannel analyzers. The application of this technique to constant counting rates, and to varying counting rates encountered in charged-particle-induced reactions and in radioactive-decay studies are treated in detail. (auth)

36575 ELECTRONIC COLLIMATION WITH FAST COINCIDENCE TECHNIQUE IN PROPORTIONAL COUNTERS. Mizuho, Mitsuru; Yamanaka, Tsuneyasu (Japan Atomic Energy Research Inst., Tokyo). J. Nucl. Sci. Technol. (Tokyo); 7: 285-90(Jun 1970).

A new method of electronic collimation is reported. The counter is composed of two proportional counters with cathodes arranged end-to-end on a common axis occupied by a common wire anode. The whole is placed in a methane filled envelope. Energy signals taken from the center wire are gated by coincidence signals between the pulses taken from the two cathodes. By such an arrangement only particles which are parallel to the center wire are detected or analyzed. The method is applicable to gas recoil neutron spectrometers and permit the conventional collimator to be dispensed with. (auth)

36576 FLUORESCENCE OF LOCALIZED EXCITONS IN ANTHRACENE CRYSTALS EXCITED BY α PARTICLES. Kaiser, G.; Flammersfeld, A. (Univ., Goettingen, Ger.). Z. Phys.; 234: 379-89(1970). (In German).

The time dependence of the scintillation light originating from free and localized excitons was analyzed by a method described by Thomas and Bollinger. The results give information about the transfer of the excitation energy and show that the lifetime of localized excitons is reduced with decreasing temperature. This effect is compared with results which Tomura and Takahashi obtained for free excitons in anthracene crystals. (auth)

36577 THEORY AND APPLICATION OF FERROELECTRIC RADIATION DETECTORS. Schlosser, P. A.; Miller, D. W.; Glower, D. D. (Ohio State Univ., Columbus). Int. J. Nondestruct. Test; 2: 19-29(Jun 1970).

A theory which explains the details of the radiation-induced charge release phenomenon of ferroelectric detectors has been developed. This theoretical development provides additional insight into the operation and application of ferroelectric devices in the broad field of radiation measurement. When placed in a radiation environment the detector responds by virtue of its pyroelectric properties. In this process the absorbed energy causes a slight change in temperature which results in a change in the internal polarization. The theory which has been developed predicts that the polarization change causes a perturbation of equilibrium electric fields and the appearance of free charge at the electrodes. The quantity of free charge which is released is proportional to the energy which is absorbed from the radiation. Ferroelectric detectors respond to ionizing radiation and have found applications in the areas of flash x-ray dosimetry and spectroscopy, laser calibration systems, linear accelerator calibration, plasma diagnostics and pulsed reactor dosimetry. The detector's ruggedness, small size, very fast time response and zero-bias operating characteristics make it ideal for the measurement of intense sources of pulsed radiation. (auth)

36578 PROCESS AND APPARATUS FOR CONTINUOUSLY DETERMINING QUANTITIES OF RADIOACTIVE NUCLEI QUALITATIVELY KNOWN AND CONTAINED IN A PHYSICAL SYSTEM. (to Comitato Nazionale per l'Energia Nucleare). French Patent 1,544,222. 23 Sep 1968. Priority date 7 Oct 1966, Italy. (In French).

A procedure and apparatus is described for the continuous determination of different quantities of n radioactive nuclei present in a physical system and qualitatively known. The procedure and apparatus are characterized by a computer to resolve a system of n linear equations with coefficients constant to n unknowns. The computer is associated with a multichannel (n channels) analyzer at the input of which are connected devices to detect the radiation. The output signals of each channel of this analyzer represent the known terms of this system of equations, themselves being constituted by the counting rate relative to n energy levels E_k chosen in the spectrum resulting from n nuclei whereas the n^2 coefficients are known values deduced from tables or established experimentally and are introduced into the computer by means of potentiometers. Each channel of the analyzer, having means for the analysis of the input level by being limited to a single energy level, is connected to only one of the operational analyzers which constitute computers of the analog type. Each channel of the analyzer and the amplifier which is connected to it can constitute a simple unit of the ensemble and can be mounted on a single support and the ensemble of these units constitute the device itself. (tr-auth)

36579 CORRECTION OF COUNTING RATES OF GEIGER-MUELLER COUNTERS. Glaeser, M. (Paedagogische Hochschule, Potsdam, Ger.). Isotopenpraxis; 6: 103-6(Mar 1970). (In German).

A correction-equation for the counting rate of Geiger-Mueller-counters is given and tested experimentally. This equation was developed on the basis of the Kramers correction theory and on experimental results. It is valid for the case of a GM counter with relatively sensitive electronics which as a non paralysable counter operates with a constant deadtime of its own. (auth)

36580 EFFECT OF THE CRYSTAL SURFACE ON THE DERIVED ELECTRON SCINTILLATION RESPONSE OF NaI(Tl). Meggitt, G. C. (Borough Polytechnic, London). Nucl. Instrum. Methods; 83: 313-16(1970).

Estimates have been made of the effects of K x-ray escape and a thin surface layer of reduced scintillation efficiency on the scintillation response ascribed to electrons following measurement of the scintillation response of an NaI(Tl) crystal to γ-rays. An approximate value for the surface parameter is obtained from the results of resolution measurements. (auth)

36581 A NOTE ON MONTE CARLO CALCULATIONS IN NaI CRYSTALS. Nardi, E. (Israel Atomic Energy Commission, Yavne. Weizmann Inst. of Science, Rehovot, Israel). Nucl. Instrum. Methods; 83: 331-2(1970).

Some improvements in the Monte Carlo calculations of the en-

ergy response of NaI crystals to gamma radiation are described. (auth)

36582 AUTOMATIC SYSTEM FOR ANGULAR CORRELATION MEASUREMENTS. Falk, F.; Linnfors, A.; Orre, B.; Thun, J. E. (Univ. of Uppsala). Nucl. Instrum. Methods; 83: 261-6(1970).

A multipurpose angular correlation instrument with an automatic controlling unit is described. The measuring program is executed in accordance with orders from a punched card. This card is easily changed when a new measuring program is needed. A magnet allows the application of longitudinal and transverse magnetic fields (up to 27 kG) to the source. The temperature of the source may be varied. This instrument is suited for studies of both perturbed and unperturbed $\alpha-\gamma$ and $\gamma-\gamma$ angular correlations. (For $\gamma-\gamma$ measurements the detector configurations are restricted.) (auth)

36583 THE USE OF SILICON HEAVY ION DETECTORS IN HIGH RADIATION FIELDS. Wesolowski, J. J.; John, W.; Held, J. (Univ. of California, Livermore). Nucl. Instrum. Methods; 83: 208-12(1970).

Techniques have been developed to permit measurements of fission fragment energies with Si detectors in the presence of a thermal neutron flux of 10^{11} n/cm^2 · sec and associated radiations. Application of the technique to search for super-heavy elements is discussed. (auth)

36584 ELECTRIC FIELD DISTRIBUTION IN Si(Li) DETECTORS. Moszynski, M. (Univ. of Aarhus, Denmark). Nucl. Instrum. Methods; 83: 329-30(1970).

The new study of the shape of pulses generated by α-particles in Si(Li) detectors brings a further confirmation of the parabolic distribution of the electric field in these detectors. (auth)

36585 SIMPLE GAS-FLOW PROPORTIONAL COUNTER. Malcolme-Lawes, D. J.; Urch, D. S. (Queen Mary Coll., London). Radiochim. Acta; 13: 114-16(1970).

A gas flow proportional counter for gas radiochromatographic analysis is described. The counter is designed to allow for quick replacement of a broken central wire. Also, the counter is used in series with a standard counter to ensure operation at a standard efficiency. The outer electrode tubing of the standard counter is impregnated with a known radiation source for calibration. (W.H.K.)

36586 IONIZATION APPARATUS FOR MEASURING ALPHA-RADIATION SURFACE CONTAMINATION. Wolschrijn, R. A. Canadian Patent 839,886. 21 Apr 1970. Priority date 16 Sep 1966, Netherlands.

A device for measuring surface contamination by α radiations on fissile fuel elements consists of an ionization chamber which is equipped for carrying out measurements at low voltage. In the ionization chamber, the fissile elements can be fastened and serve as one of two electrodes, the other electrode forming the wall of the ionization chamber. The fissile element and the chamber walls are electrically connected to an apparatus for measuring current pulses. Because of the applied low voltage, only the primary ionization current pulses caused by the α particles are measured. (Canada)

36587 IMPROVEMENTS IN OR RELATING TO SPARK CHAMBERS. Hesselbo, Torben; Groves, Arthur Derek George (to Smith Kline and French Labs. Ltd.). British Patent 1,195,284. 17 Jun 1970. Filed 6 Sep 1967.

Reference is made to spark chambers such as are used to obtain pictorial data on radionuclide distribution in biological, chromatographic, electrophoresis, etc., studies. The object of the system described is to obtain increased resolution, as compared with that obtainable with present spark chambers, and to achieve more consistent efficiency over the whole electrode area and thus avoid a zoning pattern. The spark chamber described has two substantially parallel electrodes arranged in proximity, and the walls of the chamber, which are parallel to the electrodes, are formed from a transparent or translucent material. At least one of the walls is sufficiently thin to enable radioactive particles from a radioactive pattern mounted outside the chamber to pass through. Means are provided for applying a high voltage to the electrodes and for passing a counting gas through the gas tight chamber. Means are also provided for moving the spark chamber relative to the mounting for the radioactive pattern while maintaining the electrodes in substantially the same plane. Alternatively, a platform may be provided on which a radioactive pattern can be positioned within the chamber in proximity to the lower electrode. Mechanical means may be provided to move the chamber in such a way that the electrodes are caused to describe a circular path within their plane. (UK)

36588 IONIZATION CHAMBER FOR MEASURING LOW LEVEL RADON CONCENTRATIONS. Mieth, I.; Muth, H.; Grillmaier, R. (Univ. des Saarlandes, Saarbruecken, Ger. Boris-Rajewsky-Institut, Homburg, Ger.). Z. Angew. Phys.; 29: 209-11(1970). (In German).

An ionization chamber of 2.15 l volume with walls of electropolished stainless steel is used for measuring low level radon concentrations in the air. The oxygen is eliminated out of the radon containing air samples, so that the α particles produce steep pulses which enable the use of low-noise charge-sensitive preamplifiers. The lower limit of detectable radon concentrations is $4 \cdot 10^{-14}$ Ci/l. The statistical error is about ±30% after a measuring time of 10 hr. (auth)

36589 ANALYSIS OF MATERIAL INHOMOGENEITIES IN SEMICONDUCTOR NUCLEAR PARTICLE DETECTORS USING CdTe. Zanio, K. (Hughes Research Labs., Malibu, Calif.). Nucl. Instrum. Methods; 83: 288-92(1970).

Alpha particle spectra were taken with CdTe surface barrier detectors fabricated from vapor grown semi-insulating material. At moderate biases and in the best devices, material inhomogeneities limit resolutions to 1.5% (fwhm). At the higher biases resolution improves slightly but is dominated by noise. By observation and by calculation it is shown that low energy tails observed in semiconductor detectors may be attributed to inhomogeneities. Resolution is correlated with inhomogeneity by calculation and agrees with experimental results. In order to reduce to 0.1% peak broadening due to inhomogeneities in CdTe, it is necessary to either reduce fluctuations in the electron drift length or reduce the concentration of electron traps by a factor of 10 in presently available material. (auth)

36590 CYLINDRICAL SURFACE BARRIER DETECTOR FOR USE IN A SIX-GAP BETA RAY SPECTROMETER. Dutt, J. C.; Rose, J. L.; Chapman, R. (Atomic Energy Research Establishment, Harwell, Eng.). Nucl. Instrum. Methods; 83: 181-6(1970).

The use of a cylindrical surface barrier diode as the electron detector in a six gap beta ray spectrometer is found to make a substantial improvement to the quality of in-beam internal conversion electron spectra. The method of manufacturing the diode is described in some detail and its characteristics are presented. A closed loop electronic system has been used to keep the electron peak in the detector pulse height spectrum within the window of a single channel analyser during the point by point scanning of an internal conversion spectrum. (auth)

36591 MEASUREMENT OF A MULTICURIE ACTIVITY ^{24}Na SOURCE BY ISOMERIC ACTIVATION. Lakosi, L.; Veres, A. (Inst. of Isotopes, Budapest). Nucl. Instrum. Methods; 83: 213-16(1970).

A rapid and simple method for measuring the activity of multicurie ^{24}Na sources is described. The ^{24}Na activity is evaluated from the ^{115m}In isomeric activity of the indium target irradiated with the γ-rays of the ^{24}Na source. The error of the relative activity measurement varies from 10% to 20% depending considerably on the reproducibility of the geometrical arrangement and less on the statistical data. (auth)

36592 BIASED ROUTING SYSTEM. Anttila, A.; Ehrstedt, L. (Univ. of Helsinki). Nucl. Instrum. Methods; 83: 157-9(1970).

A simple biased routing system for measurements of particle distributions in nuclear reactions is described. The circuit configurations are presented. The system has been tested in (p,α) distribution measurements using surface-barrier silicon detectors. (auth)

36593 DEGRADATION OF SPATIAL RESOLUTION IN GAMMA CAMERAS EMPLOYING SODIUM IODIDE OR GERMANIUM DETECTORS. Parker, R. P. (Inst. of Cancer Research, Surrey, Eng.). Phys. Med. Biol.; 15: 493-502(Jul 1970).

Using Monte Carlo methods γ-ray scattering in the detector was studied in relation to its effect on the spatial resolution attainable in gamma cameras. Gamma-ray energies ranging from 0.10 to 0.66 MeV were considered, with crystal thicknesses between 6.3 and 50.8 mm of NaI(Tl) and 5 to 20 mm of germanium. For a monoenergetic γ-ray, incident along the axis of a cylindrical detector, the distribution of energy depositions occurring in individual interactions in the detector is given as a function of the perpendicular distance from the incident ray to the location of the interaction. The application of pulse height discrimination to various types of gamma camera is discussed. (auth) (UK)

36594 HYBRID POSITRON SCANNER. Burnham, Charles A.; Aronow, Saul; Brownell, Gordon L. (Massachusetts General Hospital, Boston). Phys. Med. Biol.; 15: 517-28(Jul 1970).

A hybrid positron scanner, which combines the simplicity of a mechanical scanner with the increased sensitivity of a large area

array, was designed utilizing nine crystal pairs and 25 coincidence circuits. This technique has the advantage over single-pair positron systems in that greatly increased source activity may be viewed. The instrument functions reliably in clinical studies and has proven useful in supplying data for computer studies of radioisotope scan data processing. Valuable experience with multidetector systems and fast timing techniques has been gained. (auth) (UK)

36595 EXPERIENCE WITH A LOW-COST CHAIR-TYPE DETECTOR SYSTEM FOR THE DETERMINATION OF RADIOACTIVE BODY BURDENS OF M.I.T. RADIATION WORKERS. Masse, F. X.; Bolton, M. M. Jr. (Massachusetts Inst. of Tech., Cambridge). Health Phys.; 19: 27-35(Jul 1970).

A low cost chair-type device capable of absolute determination of radioactive body burdens in the range of interest for radiation protection purposes has been in use in the M.I.T. Radiation Protection Program for more than 3 yr. Experience has shown that this unit represents a practical compromise between expensive, research oriented whole-body counters capable of minute measurement, and the generally less demanding needs of the health physicist. The calibration of the unit, first accomplished by phantom studies and measurements of persons with known body burdens and later expanded by cross-calibration with the whole body counting facility at the M.I.T. Radioactivity Center, is discussed in detail. The findings of zinc-65 in cyclotron workers iodine isotopes in the thyroids of persons working with millicurie quantities of radioiodine, activation products in reactor personnel who handle irradiated samples, and detectable radionuclides in radiochemistry workers are presented. (auth) (UK)

36596 ON-LINE APPLICATION OF A SMALL DIGITAL COMPUTER TO A GAMMA SCINTILLATION CAMERA. Smith, A. H.; Barker, M. C. J. (General Infirmary, Leeds, Eng.). Phys. Med. Biol.; 15: 503-16(Jul 1970).

A system, currently in operation, by which the output of a gamma camera may be collected, stored and subsequently analysed by a small on-line digital computer, is described. Its application to the study of both static and dynamic systems is examined and the potential of the system assessed. (auth) (UK)

Nuclear Spectroscopic Instrumentation

Refer also to abstract 38322.

36597 (KURRI-TR-71) EFFICIENCY CURVES OF Ge(Li) DETECTORS AND AN INTERNAL CONVERSION COEFFICIENT SPECTROMETER. Uehara, Shinichi; Kawase, Yoichi; Okano, Kotoyuki (Kyoto Univ. (Japan). Research Reactor Inst.). 20 Dec 1969. 15p. (In Japanese). Dep. CFSTI (U. S. Sales Only).

Full energy peak efficiency curves of coaxial and planer Ge(Li) detectors have been determined in the energy range 60 keV to 2.76 MeV. IAEA standard sources of ^{241}Am, ^{57}Co, ^{203}Hg, ^{22}Na, ^{137}Cs, ^{54}Mn, ^{88}Y and ^{60}Co, calibrated to the accuracies better than 1.1%, have been used for relative and absolute efficiency determinations in the energy range 60 keV to 1.84 MeV. The relative intensities of γ- or x-rays emitted from ^{198}Au, ^{180m}Hf and ^{24}Na are well known, and these activities have also been used to determine the relative efficiencies in the energy intervals 70 to 450 keV and 1.3 to 2.76 MeV. For 22 cm^3 coaxial Ge(Li) detector, an efficiency curve for double escape peak has been determined in the energy range 1.8 to 8.6 MeV, by using the known relative intensities of γ-rays from the thermal neutron capture in ^{35}Cl. An internal conversion coefficient spectrometer, which consists of a silicon semiconductor detector and a Ge(Li) detector, has been constructed for the studies of short-lived nuclei. The well determined values of internal conversion coefficients of transitions in ^{114}In, ^{203}Hg, ^{198}Au, ^{207}Bi and ^{137}Cs have been used as calibration standards. The relative efficiency curves of two types of silicon detectors for electrons have been measured in the energy range 170 to 630 keV. The constructional details of the spectrometer and its typical performance are also described. (auth)

36598 (NYO-2472-67) ON THE CURRENT STATUS OF MOESSBAUER SPECTROSCOPY STANDARDS. Herber, Rolfe H. (Rutgers-The State Univ., New Brunswick, N. J. School of Chemistry). [1970]. 15p. Dep. CFSTI.

The present status of velocity calibration standards for Moessbauer spectrometers is discussed, including such methods as measuring the magnetic hyperfine spectrum of metallic iron, the frequency modulation of the motion of the Moessbauer source, and cosine smearing for determining line positions at large Doppler velocities. Also, isomer shift standards are discussed including iron-57, tin-119, iodine-129, and others. (W.H.K.)

36599 (SC-RR-70-96) A COMPARISON OF TWO UNFOLD CODES: UNSPEC AND SPECTRA. Berman, Marshall (Sandia Labs., Albuquerque, N. Mex.). Mar 1970. 31p. Dep. CFSTI.

Two unfold codes, UNSPEC and SPECTRA, were applied to a set of test problems. The ability of each code to unfold the spectrum was studied for the following cases: exact measurements and exact trial spectrum; measurements with errors and the exact trial spectrum; exact measurements and a false trial spectrum; and errors in both the measurements and the trial spectrum. The test problems also included the study of the effect of various detector systems, i.e., ones with broad, medium, and narrow responses. When SPECTRA was able to produce sensible answers in the overdetermined LIMIT mode, it demonstrated a significant advantage in that the solution was trial independent. In actual field measurements, however, this form of SPECTRA may not be able to produce realistic answers. Several methods of discovering particularly bad data points or poor trial spectra are discussed for both UNSPEC and SPECTRA. (auth)

36600 AN IMPROVED HIGH-ENERGY GAMMA SPECTROMETER. Diener, E. M.; Amann, J. F.; Blatt, S. L.; Paul, P. (State Univ. of New York, Stony Brook). Nucl. Instrum. Methods; 83: 115-23(1970).

A large, anticoincidence-shielded NaI(Tl) spectrometer has been developed for studies of nuclear reactions yielding γ radiation in the energy range 10-40 MeV. Improvements over earlier detector systems produce a mono-energetic γ ray response shape, around E_γ = 22 MeV, with a fwhm resolution of 3.5% and a full width at $^1/_{10}$ maximum of 7.6%. Good resolution is maintained with total counting rates of several hundred thousand pulses/sec in the NaI(Tl) crystal. (auth)

36601 THICK ABSORBERS BROADENING OF MOESSBAUER PEAKS DUE TO LACK OF COLLIMATION. Aramu, F.; Maxia, V.; Muntoni, C. (Univ., Cagliari, Italy). Nucl. Instrum. Methods; 83: 109-10(1970).

Equations are given which account for collimation geometry effects on Moessbauer peaks when the absorber is thick. (auth)

36602 A TWO-PARAMETER METHOD FOR THE MEASUREMENT OF NEUTRON ENERGY SPECTRA. Northcliffe, L. C.; Lewis, C. W.; Saylor, D. P. (Texas A and M Univ., College Station). Contract AT(40-1)-3398. Nucl. Instrum. Methods; 83: 93-100(1970).

A technique for measuring neutron energy spectra which makes use of both time-of-flight and pulse height information derived from a single detector is described. Interpretation of the two-parameter distribution is discussed, and its usefulness in the identification and elimination of background is demonstrated. A detailed procedure for conversion of the two-parameter distribution into a neutron-energy spectrum is described. (auth)

36603 A Ge(Li)-SPECTROMETER FOR THE STUDY OF THE γ RADIATION DUE TO THE RADIATIVE CAPTURE OF THERMAL NEUTRONS. Negrei, S. A.; Firsov, E. I. (Inst. of Physics, Minsk). Vestsi Akad. Navuk BSSR, Ser. Fiz.-Mat. Navuk; No. 2, 128-31(1970). (In Russian).

A γ spectrometer provided with a Ge(Li) detector possessing a sensitive volume of 2.7 cm^3 is described. The instrument was installed in the tangential beamhole of the IRT-2000 reactor of the Belorussian Academy of Sciences for the purpose of studying the γ spectra resulting from (n,γ) reactions. The lithium was deposited on the surface of the germanium crystal by sputtering and diffused into it at 420°C. The device had a resolution of 5.75 and 6.3 MeV for the 1.173 and 1.333 MeV lines of a ^{60}Co source, respectively. It was used for studying the γ-ray spectrum of ^{36}Cl from the ^{35}Cl$(n,\gamma)^{36}$Cl reaction. It was concluded that the high-resolution Ge(Li) spectrometer is well suited for investigating the γ spectrum of the radiation resulting from the radiative capture of thermal neutrons involving specimens when the capture cross section with respect to the weight of the specimens is of the order of 5 g.barn. External beam geometry was used for the measurements. (TTT)

36604 THEORY OF A HIGH-RESOLUTION β-RAY SPECTROMETER WITH AZIMUTH-DEPENDENT TRANSVERSE MAGNETIC FIELD. Schmutzler, F. (Max-Planck-Institut fuer Kernphysik, Heidelberg). Nucl. Instrum. Methods; 83: 13-14 (1970).

The use of azimuth-dependent transverse magnetic fields for β-ray spectrometers and spectrographs is treated theoretically and numerical results are given mainly for a double-focusing instrument without aperture errors up to the fourth order, a focusing angle of $\theta = 300°$, a dispersion of $D = 9.9$, and good focusing properties for extended sources. (auth)

36605 CORRECTION OF ELECTRON-CAPTURE RATIOS MEASURED BY MULTI-WIRE PROPORTIONAL COUNTER.

Vatai, E. (Inst. of Nuclear Research, Debrecen, Hungary). Acta Phys. Acad. Sci. Hung.; 28: 103-8(1970).

The corrections of the measurement of electron capture ratios by the multi-wire counter are calculated using accurate integrals and numerical methods of integration. The effects of the correction on the experimental L/K and M/L ratios are discussed. (auth)

36606 METHOD OF FAST-NEUTRON SPECTROMETRY BY MEANS OF A SEMICONDUCTOR DETECTOR AND A SMALL SCATTERING CHAMBER. Chuang, L. S. (Chinese Univ., Hong Kong); Lu, T. H. Nucl. Instrum. Methods; 83: 197-200(1970).

To provide a small fast-neutron spectrometer, a tiny solid state detector of surface barrier type is combined with a thin polyethylene film at a distance. These are separated by a proton beam collimation and defining system to determine the absolute neutron flux. The polyethylene target is fixed in a bellows which also carries the detector. This detector can be rotated on a goniometer in an angular range of 0–90°. Monoenergetic fast-neutrons from a d-D source were detected with and without the polyethylene target in place. Subtraction of the recoil proton spectra from the corresponding background spectra, measured at three different scattering angles from the same incident neutrons, showed recoil proton peaks at energies identical with that of values calculated from kinematics. Absolute determination of the number of incident neutrons at the target can be made for an incident neutron energy as high as can be accepted by the detector combined with the goniometer. The neutron measured agrees well, within the experimental error, with that calculated. (auth)

36607 MOESSBAUER SPECTROMETER WITH A LARGE DRIVING FORCE. Katano, R. (Kyoto Univ.). Nucl. Instrum. Methods; 83: 187-92(1970).

A constant-acceleration Moessbauer spectrometer using an electromechanical transducer driven by a high power dc-amplifier at a low sweep cycle of 2.2 cps has been developed. This system, capable of activating a 500 g drive rod, is useful to give the Doppler-shift velocity to a sample supported inside a liquid-helium cryostat. Details of mechanical assembly, driving dc-amplifier, operational circuit, and photo-transistor pulse generator are described. (auth)

36608 DESIGN OF MAGNETIC SPECTROMETERS BY THE USE OF A DIGITAL COMPUTER. Castman, B.; Groth, T.; Olsen, B.; Pettersson, G. (Univ. of Uppsala). Nucl. Instrum. Methods; 83: 149-56(1970).

The numerical basis for the investigation of suitable goal-fields for the design of flat spectrometers is studied. The properties of a known method for calculation of magnetic fields of cylindrical symmetry are investigated and the method is used to calculate various theoretical goal-fields. Iso-aberration contours are evaluated by integration of particle trajectories and illustrated for a number of typical fields. (auth)

36609 STUDY OF STATISTICAL PROPERTIES OF POLY-ENERGETIC GAMMA-RAY SPECTRA. Eckhoff, N. D.; Ervin, P. F.; Haskin, F. E. (Kansas State Univ., Manhattan). Nucl. Instrum. Methods; 83: 272-6(1970).

Two sets of spectra were collected using ^{137}Cs and ^{60}Co, one set with a high background and the other with a low background. Variance-covariance calculations, using these data, show that standard variance assumptions are valid. Further, the variance-covariance matrices are quite sparse. However, unfolding the mean value complex spectra, using standard (zero covariances) assumptions, yielded estimators with standard deviations approximately 2.7 times lower than those obtained where the actual variance-covariance matrix was used in the least-squares solution. (auth)

36610 AN ALL SODIUM IODIDE ANTICOINCIDENCE SHIELDED TOTAL ABSORPTION SPECTROMETER FOR LOW-LEVEL RADIONUCLIDE ANALYSES. Wogman, N. A. (Battelle Memorial Inst., Richland, Wash.). Contract AT(45-1)-1830. Nucl. Instrum. Methods; 83: 277-82(1970).

An anticoincidence shielded gamma-ray spectrometer has been designed from a 34 cm dia by 31 cm thick NaI(Tl) ingot which surrounds an 18 cm dia by 22 cm thick NaI(Tl) principal detector. The spectrometer and the principal crystal are hermetically sealed in a single container. Low background construction materials, as well as low ^{40}K content phototubes, serve to reduce the background. The low ^{40}K phototubes reduced the ^{40}K detected by the principal crystal approximately twofold compared to standard glass phototubes. The background in the energy range from 0.1 to 3 MeV was reduced from two- to fivefold by the anticoincidence shield. The efficiency of the system for a point and a 70 ml source is approximately fivefold greater than that of a 7.5 cm dia by 7.5 cm thick NaI(Tl) crystal. By means of the anticoincidence crystal, the Compton edge for ^{137}Cs was reduced by 2.5-fold to produce a peak-to-Compton edge ratio of approximately 160:1. The system has been utilized for low-level radionuclide analyses of single gamma-ray emitters and has been compared to NaI(Tl) multidimensional and Ge(Li) gamma-ray spectrometers. (auth)

36611 LIQUID SCINTILLATION SPECTROMETER DATA PROCESSING BY DESK-TOP COMPUTER. Williams, M. A. (Univ. of Sheffield, Eng.); Cope, G. H.; Jackson, J. L.; Hill, P.

A desk-top computing system has been programmed to store accurately the quench curves necessary for the calculation of total disintegrations/minute (d.p.m.) of samples containing either one or two radioactive isotopes. In producing d.p.m. values background counts are subtracted, and in binary-labelled samples the counts attributable to each radioactive isotope are separated. The programme also relates d.p.m. to the weight, volume and density of the sample. Each variable is easily recalled and adjustments can be made for different batches of samples without reprogramming. Equally easily changes of radioactive isotope, quenching agent, scintillator or window setting can be accommodated. Quadratic equations are used to express the quench curves. Counting efficiencies obtained when the coefficients in the quadratic equations are derived from three carefully chosen points on a quench curve are compared with those obtained when the coefficients are derived by the method of least squares. The results of both mathematical approximations are compared with the efficiencies read by the eye from graphs. (auth) (UK)

36612 DETERMINATION OF X-RAY SPECTRA USING ATTENUATION MEASUREMENTS AND A COMPUTER PROGRAM. Twidell, J. W. (Univ. of Essex, Eng.). Phys. Med. Biol.; 15: 529-39(Jul 1970).

A computer program was written and tested which will rapidly produce reliable x-ray spectral distributions in intensity or photon flux density from measurements of attenuation data through metal filters under narrow beam conditions. Spectra of two 2 MeV sources were produced which may be compared with a spectrum derived by the Laplace Transform method of analysing attenuation data, and with a spectrum produced by crystal scintillation spectrometry. Convenient and relatively cheap determinations of x-ray spectra using LiF dosemeters are discussed, and the spectrum from a 500 keV single-shot flash x-ray machine is determined as a demonstration of the method. (auth) (UK)

High Energy Physics Instrumentation

Refer also to abstracts 36654, 37699, and 38045.

36613 (CERN-70-17) HIGH-PRECISION GEOMETRICAL AND KINEMATICAL ANALYSIS OF MAGNET SPARK CHAMBER EVENTS. Muehlemann, P.; Wilson, J. D. (European Organization for Nuclear Research, Geneva (Switzerland)). 5 Jun 1970. 33p. Dep. CFSTI (U. S. Sales Only).

A geometrical reconstruction program based on fitting the track in a 1-component variable magnetic field is described for the new series of experiments to study diffraction dissociation in $\pi^- + A \rightarrow \pi^- + \pi^- + \pi^+ + A$ and $K^+ + A \rightarrow K^+ + \pi^+ + \pi^- + A$ interactions on a nucleus A at energies from 9 to 16 GeV. Establishment of basic geometrical quantities which define the coordinate system is discussed including fiducial marks and the optical axes. Systematic instrumental errors are discussed including optical distortions and correction, systematic errors on spark positions, and determination of space resolution and energy resolution. Track fit and effect of nonuniformity of magnetic field and the extrapolation of the tracks in the fringing field region and determination of the vertex are discussed. Over-all resolution tests are described including the τ-decay test and external errors on track parameters and track parameter errors from multiwire proportional chamber information. (W.H.K.)

36614 (IFVE-SEF-69-62) ANTICOINCIDENCE CIRCUIT EFFICIENCY AT REGISTRATION OF HIGH-ENERGY PARTICLES. Grachev, M. I.; Rykalin, V. I.; Sen'ko, V. A.; Shuvalov, R. S. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov. Institut Fiziki Vysokikh Energii). 1969. 22p. (In Russian). Dep. CFSTI (U. S. Sales Only).

This paper presents the consideration of the anticoincidence efficiency, having different circuit solutions of the anticoincidence beam channel. The causes of the anticoincidence inefficiency, when the pulses are produced by the scintillation counters with the help of univibrators based on the tunnel diodes and Schmidt triggers, are considered. It is shown that in such cases the anticoincidence efficiency in the particles beam may be better than 10^{-7}, if the anticoincidence beam channel is constructed in the proper way. (auth)

36615 (KFKI-70-10-HEP) MOMENTUM ESTIMATION OF ELECTRONS TRAVERSING HEAVY MEDIA IN HOMOGENEOUS

MAGNETIC FIELD. Nagy, E. (Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezete, Budapest). [1969]. 13p. Dep. CFSTI (U. S. Sales Only).

A modification of the SPIRAL method for determining the four momentum of electrons traversing on homogenous magnetic field inside a heavy medium (heavy liquid bubble chamber or nuclear emulsion) is presented. The main difference is that in the method presented, the random nature of the bremsstrahlung is taken into account as fluctuation in the trajectory called the Coulomb mean, whereas the SPIRAL method introduces an additional term which supposes that the displacement from a mean trajectory follows a Gaussian law even when no Coulomb scattering and measurement error are present. (W.H.K.)

36616 (SLAC-PUB-754) SLAC LARGE WIRE SPARK CHAMBER SPECTROMETER. Leith, D. W. G. S.; Luste, G. J. (Stanford Linear Accelerator Center, Calif.). Jun 1970. 15p. (CONF-700525-1). Dep. CFSTI.

From Experimental Meson Spectroscopy Conference, Philadelphia, Pa.

The development of a large wire spark chamber spectrometer for studying peripheral processes in the energy range of 5 to 20 GeV/c and particularly meson spectroscopy is described. The design of the system is described, and its performance for studying the $\pi^- + p \rightarrow \pi^+ + \pi^- + \pi^- + p$ interaction at 16 GeV/c is given. (W.H.K.)

36617 PREAMPLIFIER FOR MAGNETOSTRICTION SPARK CHAMBERS. De Biasi, M.; Giannelli, G.; Marangelli, B. (Univ., Bari, Italy). Nucl. Instrum. Methods; 83: 61-6(1970).

The specifications of a non overloading preamplifier for magnetostriction spark chambers are described in detail. The design of the preamplifier that has been developed is discussed. Its characteristics are: gain of 1300, risetime of 80 nsec, equivalent input noise of 10 μV r.m.s. It recovers within 5 μsec after the spark chamber's discharge. (auth)

36618 KIEL COSMIC RAY MUON SPECTROGRAPH. Allkofer, O. C.; Carstensen, K.; Dau, W. D.; Heinrich, W.; Kraft, E.; Weinert, M. (Univ., Kiel). Nucl. Instrum. Methods; 83: 317-25(1970).

A cosmic ray magnetic spectrograph for measurements of muon spectra and charge ratio at sea level in the high energy region has been constructed. This spectrograph can be turned in a continuous way from a vertical to a horizontal position. The solid angle of the spectrograph is defined by a telescope of four scintillation counters, the deflection of the muons takes place in a solid iron magnet, and the tracks are indicated by six double gap spark chambers which are photographed. The acceptance of the apparatus amounts to 15.8 cm^2sr. The geometrical acceptance half-angle is 5.2° in the deflection plane as well as in the perpendicular plane. The lowest momentum that can be measured with the apparatus is 7 GeV/c and the maximum detectable momentum is about 1 TeV/c. (auth)

36619 A FACILITY FOR COMPUTER EVALUATION OF PROPORTIONAL WIRE CHAMBER DESIGNS. Simanton, J. R.; Bourkland, K. R.; Marquardt, R. F.; Lales, J. (Argonne National Lab., Ill.). Nucl Instrum. Methods; 83: 165-75(1970).

A shielded test facility, instrumented and interfaced to a digital computer, provides on-line evaluation during design and construction optimization studies for a large, proportional-mode wire chamber. Emphasis is on design and performance of sequence and readout electronics. Advantage of and prospects for "amplifierless" readout are discussed. (auth)

36620 EFFECT OF ULTRASOUND ON THE FORMATION OF THE TRACKS OF IONIZING PARTICLES IN A LIQUID-HYDROGEN BUBBLE CHAMBER. Akulichev, V. A.; Gavrilov, L. R.; Grebinnik, V. G.; Zhukov, V. A.; Libman, G.; Manych, A. P.; Rozenberg, L. D.; Rudin, Yu. I.; Selivanov, G. I. (Acoustics Inst., Moscow. Joint Inst. for Nuclear Research, Dubna, USSR). Sov. Phys. - Acoust. (Engl. Transl.); 15: 439-43(Apr-Jun 1970).

Translated from Akust. Zh.; 15: 505-9(Oct-Dec 1969).

The effect of ultrasound on the formation of the tracks of ionizing particles in a liquid-hydrogen bubble chamber has been studied experimentally. The structural features and characteristic operating conditions of acoustical systems such that ultrasound has a significant influence on the growth of the bubbles forming the tracks are described. (auth)

36621 SYSTEM OF SPARK CHAMBERS WITH MAGNETOSTRICTIVE READOUT. Landaud, G. (Laboratoire de Physique Corpusculaire, Caen, France); Le Brun, C.; LeMeilleur, F.; (and others). Nucl. Instrum. Methods; 83: 309-12(1970). (In French).

Magnetostrictive wire spark chambers are described. Accuracy and systematic errors are checked closely. The advantages and simplicity of the system are given. (auth)

36622 IMAGE INTENSIFIER PHOTOGRAPHY OF ULTRA-HIGH ENERGY CASCADES IN AN IONIZATION SPECTROMETER. I. APPARATUS. Huggett, R. W.; Sandor, T.; Webb, J. E. (Louisiana State Univ., Baton Rouge). Rev. Sci. Instrum.; 41: 1007-12(Jul 1970).

Apparatus is described which has been developed to photograph the development of simultaneous nuclear electromagnetic cascades in an ionization spectrometer. Light is emitted by the cascades as they pass through layers of plastic scintillator within the spectrometer. This light is imaged onto the photocathode of a four-stage cascade-type image intensifier with magnetic focusing. When suitable events occur within the spectrometer the intensifier is pulsed so as to transmit and intensify the stored image. The output screen of the intensifier is then photographed. Two optical systems and image intensifier cameras are used so as to obtain right angle stereoscopy of the cascades. (auth)

36623 STUDY OF THE ANALOG SIMULATION OF THE EXPANSION SYSTEM IN THE BUBBLE CHAMBER OF HEAVY LIQUIDS GARGAMELLE. Bezaguet, A. (Ecole Polytechnique, Paris); Deat, M.; Tellier, N.; Queru, P. pp 63-71 of Analog and Hybrid Computation Applied to Nuclear Energy. Brussels, Presses Academiques Europeennes (1969). (In French).

From International Symposium on Analogue and Hybrid Computation Applied to Nuclear Energy, Versailles, France. See CONF-680941.

The bubble chamber "Gargamelle" designed for use at CERN is formed from a 12-m^3 chamber filled with heavy liquid. The latter is subjected to a compression cycle consisting of an expansion of 25 to 10 bars in 60 milliseconds followed by a recompression to the initial level in a similar time. This cycle is repeated with a period between 1.4 and 8 seconds. It is obtained by nitrogen pressures on deformable membranes closing part of the chamber. A description is given of the installation allowing the application of the necessary pressures on the membranes. It consists essentially of a series of five reservoirs for which the pressures are kept constant by a system of control valves; one can thus regulate the flow of gas among the various elements of the circuit, of which the circulation is assured by a two-stage turbocompressor. The mathematical model used in the analogous study is described. This model was perfected by the engineers of the Société Rateau and tested at the Department of Electronic Calculators of SACLAY. The analogous study itself is carried out by means of the coupling of two machines of Electronic Associates Incorporated: a "PACE 231 R" and an "8800," the logic elements of the latter were indispensable in order to simulate the pulse output and the range of digital signals from the control system. Different stages of the analogous study are indicated of which the last is the simulation of the complete ensemble of the regulated digital system. In conclusion the results obtained on the analog computer are compared with results obtained from numerical calculation and with experimental measurements on the chamber. (tr-auth)

36624 DATA PROCESSING IN HIGH ENERGY PHYSICS EVALUATION OF BUBBLE-CHAMBER PICTURES. II. KINEMATICAL ANALYSIS BY GRIND. Lazak, D. Elektron. Datenverarb.; No. 8, 367-78(1969).

GRIND is a computer program applied to the kinematic analysis of bubble-chamber pictures. Using the geometry data arising from THRESH and some special data (GRIND-title) each assumed hypothesis for the explanation of an event is tested by a statistical fit to the given data. The probability of every tested hypothesis is calculated. GRIND comprises about 200 subroutines in the unpartitioned form and uses in this mode 64 K core-capacity. Part I of the presented paper describes the principles of the GRIND-fit, part II outlines the program structure, and part III outlines the used input and output. CERN updates and improves GRIND continuously. (auth)

Radiation Dosimeters

36625 (JUL-603-ST, pp 190-1) DOSIMETRY FOR PERSONNEL AND LOCATION: TESTING THE ENERGY DEPENDENCE OF SOME IONIZATION CHAMBERS FOR β DOSIMETRY. Heinzelmann, M. (Kernforschungsanlage, Juelich (West Germany). Zentralabteilung Strahlenschutz). (In German).

In practice, personnel dosimetry for β radiation is performed with ionization chambers primarily designed for γ-ray dosimetry. To test reliability of such instruments, as far as β-emitters are concerned, they are exposed to β radiation from 0.23 to 2.27 MeV maximal energy. The radiosensitive skin is covered by an insensitive layer of approximately 7 mg/cm^2. Ionization chambers, calibrated with ^{60}Co γ radiation, indicate quite accurately high energy β radiation from $^{90}Sr-^{90}Y$, while only one quarter is measured of the true value of soft β radiation emitted by ^{147}Pm. Vari-

ous types of dosimeters give similar results. It is concluded that none of these dosimeters measure low energy β radiation with acceptable accuracy. (H.B.G.)

36626 (STI/DOC-10/109) PERSONNEL DOSIMETRY SYSTEMS FOR EXTERNAL RADIATION EXPOSURES. Technical Reports Series No. 109. Francois, H.; Gupton, E. D.; Maushart, R.; Piesch, E.; Somasundaram, S.; Spurny, Z. (International Atomic Energy Agency, Vienna (Austria)). 1970. 159p. IAEA $4.00.

The technical details and the advantages and limitations in practical application of devices and systems which are used extensively or in advanced stages of development for the assessment of external radiation exposures of personnel are given. Photographic film, gaseous ionization, photoluminescence, thermoluminescence, and activation detectors which are used in personnel monitoring are discussed. Also, nuclear track methods for neutron dosimetry are considered. The techniques of calibration and the maintenance of personnel exposure records are described. (W.H.K.)

36627 (UCLA-12-781) INFLUENCE OF TEMPERATURE DURING THE GAMMA IRRADIATION THERMOLUMINESCENCE OF SOILS AND LiF AND CaF_2 DOSIMETERS. Nishita, H.; Hamilton, M. (California Univ., Los Angeles. Lab. of Nuclear Medicine and Radiation Biology). [1970]. Contract AT(04-1)-Gen-12. 20p. Dep. CFSTI.

The influence of temperature (0° to 70°C) during the exposure period to cobalt-60 gamma radiation on the thermoluminescence of two soils and LiF (TLD-100) and CaF_2 (TLD-200) dosimeters was examined. The thermoluminescence of these materials was affected by their temperature during irradiation. The effect of temperature during irradiation was eliminated in the soils by using a pre-readout, post-irradiation heating regimen of 100°C for 20 min or by allowing the thermoluminescent decay to progress for an appropriate length of time. For the two soils examined, this time was about 58 and 168 hr. The pre-readout, post-irradiation heating regimen (100°C for 10 min) sometimes used for TLD-100 and TLD-200 dosimeters did not eliminate the effect of temperature during irradiation. (auth)

36628 CHEMICAL DOSIMETRY OF SOFT X-RADIATION WITH FERROUS-FERRIC SYSTEMS (FRICKE DOSIMETRY) BY POLAROGRAPHIC AND PHOTOMETRIC ANALYSIS. Schreiber, H. (Institut fuer Strahlenforschung, Luebeck, Ger.); Hollandt, H.; Meissner, J. Atomkernenergie; 15: 177-84(1970). (In German).

G values of ferrous-ferric systems (Fricke solutions) have been determined for the range of soft X-radiation using solutions without organic additions and such sensitized by benzene and by benzoic acid. The solutions were exposed to selective filtered K_α rays of silver-, molybdenum- and copper anodes as well as to continuous X-rays (Bremsstrahlung) of a tungsten X-ray tube (60kV, 1 mm Al filter). The calculation of absorbed doses is based on the mass attenuation coefficients of the solutions specially measured for the radiations used. The Fe^{3+} yield has been determined polarographically and photometrically. The results obtained are in accordance with graphs of G values as a function of LET, published by Allen (1961) and in ICRU-Handbook 85 (1964). However, they do not confirm a similar curve of Minder (1960, 1966) and higher values of other authors. Probably the discrepancies are due to sensitizing organic impurities in the solutions. In our experiments impurities were carefully excluded which was guaranteed by controlling the rate of autoxydation of long time stored solutions either with or without added NaCl. No significant differences of G values originating from photometric and polarographic analysis were stated for unsensitized Fricke solutions. Presuming a standard deviation of ±3% for single values the detection limit was found to be about 500 R for polarographic and 1000 R for photometric methods. Our G values of Fricke solutions sensitized by benzene and by benzoic acid confirm the dates of some authors while they are contradictory to those of others. The relative alterations of G values by sensitization have been proved to be independent of radiation energy. For dosimeter solutions sensitized by benzoic acid, G values and sensitization factors differed according to the photometric or polarographic methods applied. As a possible explanation influences of radiolytically caused products in the solutions are discussed. (auth)

36629 EFFECTS OF TEMPERATURE ON COBALT GLASS DOSIMETERS. Lee, Philip Kenton. Lafayette, Ind.; Purdue Univ. (1969). 184p.

Thesis.

The temperature sensitivity of cobalt borosilicate glass dosimeters was investigated. In one study dosimeters were exposed at levels of 2×10^4, 10^5, 5×10^5, and 10^6R to ^{60}Co gamma radiations in temperature environments ranging from 0°C to 200°C. Following exposure, the dosimeters were given one hour heat treatments of 25°C, 100°C, or 200°C and then stored at temperatures of 0°C, 25°C, 50°C, 75°C, or 100°C. Over a four month period following exposure, spectrophotometric measurements of the radiation-induced absorbance levels were taken at wavelengths of 300, 375, and 500 mμ. The effects of pre- and post exposure temperature environments ranging up to 400°C were investigated in other studies, and a temperature treatment for complete clarification of the radiation-induced absorbance was established. (Diss. Abstr.)

36630 NEUTRON DOSIMETRY IN THE ENERGY RANGE BETWEEN 10 AND 100 MeV. Tesch, K. (Deutsches Elektronen-Synchrotron, Hamburg). Nucl. Instrum. Methods; 83: 295-9 (1970).

For neutron dosimetry in the energy range 10 to 100 MeV two counting devices are described. The first one is a scintillation counter with a liquid scintillator; the threshold is chosen in such a way that the correct response curve is given. Pulses from other particles are suppressed by pulse-shape discrimination. The second device is a simple extension of the multi-sphere method. Some results of dose measurements in the mentioned energy range are briefly described. (auth)

36631 AMARANTH AS A LOW-LEVEL GAMMA RAY DOSIMETER. Oza, P. M.; Parekh, J. M.; Rao, P. S. (Central Salt and Marine Chemicals Research Inst., Bhavnagar, India). Radiochim. Acta; 13: 117-18(1970).

Development of a dosimeter for the low dose range, based on the discoloration of a stable water soluble food dye, Amaranth, is described. Determination of the spectrophotometric absorption coefficient and calibration curve at 520 mμ is presented. Linearity, temperature dependence, and dose range are discussed. (W.H.K.)

36632 SECONDARY-STANDARD IONIZATION CHAMBER DESIGN. Kemp, L. A. W. (National Physical Lab., Middlesex, Eng.). Phys. Med. Biol.; 15: 557-8(Jul 1970).

Due to the inadequacy of secondary standard instruments a therapy level exposure meter with its associated ionization chamber was developed. The design of the chamber incorporated very high purity, high density extruded graphite in the cap material and the hollow collecting electrode was made from aluminium of 99.99% purity. (UK)

36633 ENERGY RESPONSE OF LiF, CaF_2, AND $LiF_2B_4O_7$ TO HIGH ENERGY RADIATIONS. Burlin, T. E. (Central London Polytechnic). Phys. Med. Biol.; 15: 558-61(Jul 1970).

General cavity theory was applied to dosemeters in electron fields and the theoretical results discussed and compared with those of Almond and McCray (Phys. Med. Biol. 15:335-43) with which they do not agree. The attenuation of electrons as assumed by Almond and McCray was not found to occur for material of low atomic weight. However, it is still thought possible that the energy response of phosphors can be explained by cavity theory. (UK)

36634 LIGHT SENSITIVITY OF LiF THERMOLUMINESCENT DOSIMETERS. Freeswick, D. C.; Shambon, A. (Atomic Energy Commission, New York). Health Phys.; 19: 65(Jul 1970).

Wide variations of the output for LiF dosimeters exposed to between 0.75 and 3.0 mR were found to be due to the dosimeters being sensitive to flourescent lights. (UK)

Radiometric Instruments

Refer also to abstracts 36571 and 37321.

36635 RESPONSE OF THE GAMMA-RAY DENSITY GAUGE TO THE BOUNDARY BETWEEN TWO MATERIALS. Uemura, Teiji (Industrial Research Inst., Osaka). Jap. J. Appl. Phys.; 9: 673-8(Jun 1970).

Calculations for the single scattering of gamma rays were made on the case where the surface density gage was placed on the boundary between two materials of different densities. The calculations and experiments were performed for the boundary perpendicular to the gage axis and for that parallel to the gage axis under various gage configurations. The manner of response to the boundary varied with the source-detector separations $\mu_0\rho D$ which is expressed in mean free path of incident rays and with the solid angle of incidence of the gamma rays. When the value of $\mu_0\rho D$ and the difference between the densities of two materials were small, the response to the boundary nearly took the shape of a unit step function. (auth)

36636 METHOD OF AND APPARATUS FOR DETERMINING THE MEAN SIZE OF GIVEN PARTICLES IN A FLUID. Carr-Brion, Kenneth Garfield; Jenkinson, Doris Audrey (to National Research Development Corp.). British Patent 1,193,840. 3 Jun 1970. Filed 15 Mar 1967.

Improvements are described to the method described in B.P. 1,127,342, which is based on the fluorescence intensity from the particles when submitted to irradiation. When the irradiation is incident on heterogeneous material, such as a liquid containing solid particles in suspension, the intensity of the fluorescence emitted by the particles is a function of mean particle size, assuming that the particles either consist of, or contain, a solid which fluoresces. The dependence of fluorescence on mean particle size applies, however, only for a certain range of particle sizes. In order to provide an indication of the mean size of solid particles that form a fluorescent component of the particles in a fluid, it is necessary to distinguish the fluorescent effect due to all the particles and the effect due to the concentration of the fluorescence component. In the method described this is achieved by measuring the fluorescence intensity due to two separate beams of radiation having different mean energies, chosen so that one beam shows a marked "particle size effect" and the other a negligible effect. The radiation sources may be radioisotopic or x-rays of different energies, and the fluorescence radiation is preferably passed through a filter before reaching the detector to prevent radiation backscatter for the fluid and particles being detected. The fluid may be passed through two chambers in succession, the two radiations passing respectively into these chambers. Calibration graphs are prepared showing the relation between the intensity of fluorescence radiation and mean particle size. (UK)

36637 IMPROVEMENTS IN OR RELATING TO FLOW MEASUREMENTS. Clayton, Colin Geoffrey; Spackman, Ramon (to United Kingdom Atomic Energy Authority). British Patent 1,195,229. 17 Jun 1970. Filed 21 Nov 1966.

Reference is made to the technique of flow measurement using radioisotopes. One such method comprises injecting a tracer into the flowing stream and measuring its transit time between two points of known separation. In practice it is not easy to determine accurately the precise instant of transit using conventional count rate meters and recorders. In the method described the instant of transit is determined using an integrating rate meter at each of the two points. In order to compensate for background radiation a "backing-off" count is applied to each ratemeter. (UK)

36638 HUMIDITY MEASUREMENT FOR COKE AND BLAST FURNACE GAS. Luckers, L. Rev. Met. (Paris); 66: 557-62 (Jul-Aug 1969). (In French).

Principles and experimental results are discussed with regard to measurements of coke moisture by neutron probes, and also blast gas moisture by mirror (dew point) hygrometers. The article proper is followed by a discussion with other users. Results are generally satisfactory though difficulties have been experienced with some types of equipment. (UK)

Miscellaneous Instruments and Components

Refer also to abstracts 38527, 38549, and 38598.

36639 (AECD/MISC-2) TECHNICAL [PROGRESS] REPORT, JULY 1, 1968-JUNE 30, 1969. Ahmed, Ekhlasuddin; Karim, Mesbahul; Islam, Mizanul (eds.) (Atomic Energy Centre, Dacca (Pakistan)). 29 Dec 1969. 115p. Dep. CFSTI (U. S. Sales Only).

A brief review of research and development in nuclear physics, computers, electronics, chemistry, isotopes, health physics, agriculture, radiobiology, and medicine is given. Research contracts, lectures and seminars, publications, and internal reports are listed. (W.H.K.)

36640 (CEA-N-1319) FAST DC-COUPLED 4-FOLD FAN-OUT CIRCUIT. Lavaitte, A. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). May 1970. 11p. (In French). Dep. CFSTI (U. S. Sales Only).

A fanout circuit having a rise time and a fall time of 1.5 nsec, a voltage gain slightly higher than 1 and an asymmetry between the 4 outputs of less than 5.1 is described. The outputs are matched to 50 Ω and can deliver 2 V on a 50 Ω load. The circuit works with negative pulses. (France)

36641 (CONF-691043) PROCEEDINGS [OF] SEVENTH ANNUAL ALLERTON CONFERENCE ON CIRCUIT AND SYSTEM THEORY. Conference Held October 8-10, 1969, Monticello, Illinois. Haddad, A. H.; Metze, G.; Trick, T. N. (eds.) (Illinois Univ., Urbana. Institute of Electrical and Electronics Engineers, New York). 931p.

115 papers are presented on information and coding theory, digital systems, communication sciences, control systems, network theory, and computer-aided design. (W.H.K.)

36642 (DP-Report-77) ERRORS INTRODUCED INTO THERMOCOUPLE SYSTEMS BY UNEXPECTED SIGNALS FROM INSULATING MATERIALS. Project DRAGON. Kingdon, J. (Atomic Energy Establishment, Winfrith (England)). Mar 1962. 22p. Dep. CFSTI.

At temperatures in excess of 300°C common insulating materials give temperature dependent signals of considerable magnitude. These signals have been found to introduce errors into temperatures indicated by thermocouples. (auth)

36643 (DP-Report-86) A ROBUST FLOWMETER FOR THE MEASUREMENT OF VERY SMALL FLOWS. Project DRAGON. Husain, L. A.; Robinson, C. H. (Atomic Energy Establishment, Winfrith (England)). Apr 1963. 22p. Dep. CFSTI.

The design, manufacture and calibration of consolidated porous media flowmeters are described. Calibration techniques and apparatus are discussed in some detail. (auth)

36644 (DP-Report-167) TESTS AND DATA CONCERNING PLATINEL, A NEW HIGH TEMPERATURE THERMOCOUPLE. Project DRAGON. Donne, M. Dalle (Atomic Energy Establishment, Winfrith (England)). Mar 1963. 12p. Dep. CFSTI.

This report describes work done to investigate the use of the Platinel (Al-Pd/Au-Pd-Pt) thermocouple as an alternative to Chromel/Alumel and Platinum/Platinum-Rhodium thermocouples, at high temperatures. Performance tests on Platinel thermocouples are described and their results discussed in relation to the performance of the two alternatives. (auth)

36645 (GEPP-73) DIGITAL OSCILLOSCOPE PLUG-IN UNITS FOR INSTANT WAVEFORM ANALYSIS. Howell, J. F. (General Electric Co., St. Petersburg, Fla. Neutron Devices Dept.). 2 Oct 1969. Contract AT(29-2)-656. 36p. Dep. CFSTI.

This report describes a family of digital instruments that provide measurements such as the integral of a single pulse, duration of a single pulse, time between two pulses, peak amplitudes of a pulse at a specific time. The Time Interval Detector (TID), the Peak Rate Detector (PRD), and the Gated Integrator (GI) are packaged as plug-ins for Tektronix oscilloscopes that accept letter series plug-ins. These instruments retain normal analog readout, and in addition, provide automatic, high precision digital interpretation of waveforms. Specifications and circuit diagrams are included. (auth)

36646 (ICRU-15) CAMERAS FOR IMAGE INTENSIFIER FLUOROGRAPHY. (International Commission on Radiation Units and Measurements, Washington, D. C.). 15 Sep 1969. 16p. ICRU, Washington, D. C. $2.50.

The design and operation of cine cameras for x-ray fluorography for radiodiagnosis are discussed. Basic components, timing considerations, and geometry and dimensions are described. (W.H.K.)

36647 (NP-18125) PAKISTAN ATOMIC ENERGY COMMISSION. Annual Report, 1967-68. (Pakistan Atomic Energy Commission, Karachi). 72p. Dep. CFSTI (U. S. Sales Only).

Research and developments in reactor utilization instrumentation, physical sciences, biosciences, atomic energy medical centers, and nuclear minerals survey are outlined. Also, the training program, international collaboration, and budget and finance are discussed. Publications by PAEC scientists are listed. (W.H.K.)

36648 (NP-tr-1899) RADIOCRYSTALLOGRAPHIC APPARATUS FOR THE EXAMINATION OF IRRADIATED MATERIALS. Bloch, J. Translated by W. G. Stripp (Atomic Energy Research Establishment, Harwell, Eng.), from report CEA-1449. 23p. Dep. CFSTI (U. S. Sales Only).

A double diffraction x-ray spectrometer is described for x-ray diffraction analysis of radioactive samples. A system of collimator slits and crystal monochromators is designed to eliminate background radiation from the radioactive sample. A Geiger-Mueller counter in a lead block is used as detector. (W.H.K.)

36649 (RISO-M-1206) ELECTRONICS DEPARTMENT SEMI-ANNUAL REPORT FOR THE PERIOD APRIL 1-SEPTEMBER 30, 1969. (Danish Atomic Energy Commission, Risoe. Research Establishment). Feb 1970. 24p. (R-13-69). Dep. CFSTI (U. S. Sales Only).

Development of the computer-controlled instrumentation for the DR 2 reactor is described. Participation in the uranium prospecting program in Greenland is outlined, and field measurements of zirconium and niobium by x-ray fluorescence analysis are described. Also, the development of the data handling system for the isotope laboratory, development of the reactor alarm-event recording system, and development of the difference analyzer using

a waveform eductor for plasma physics experiments are summarized. Publications by the staff members are listed. (W.H.K.)

36650 (RT/MET-(69)4) FURNACE FOR NEUTRON-SPECTROMETRY EXPERIMENTS ON MONOCRYSTALS. Esposito, L.; Rizzi, G.; Cubiotti, G. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 6 Oct 1969. 5p. (In Italian). Dep. CFSTI (U. S. Sales Only).

A description of a furnace for operation up to a temperature of 700°C for neutron spectrometry on monocrystals is reported. The sample can be kept in inert gas atmosphere or in vacuum. In equilibrium condition the temperature stability is within 2°C with a difference of 1°C between the lower and the upper limit of the sample. (auth)

36651 (SC-T-70-4027) INPUT-OUTPUT SUPERVISOR. Dupuy, Roger (Commissariat a l'Energie Atomique [Saclay (France). Centre d'Etudes Nucleaires]). Translated by Anna Vakar (Sandia Labs., Albuquerque, N. Mex.), from report CEA-R-3860. 125p. Dep. CFSTI.

The techniques for managing peripherals in input-output supervisors are examined. Topics include transmissions, interrupts, software-hardware interface, system design, recognition and processing of interrupts, input/output control system (CES), tasks common to CES and RTI, conclusions on input-output supervisors, stacking requests or stacking interrupts, memory management, the different interrupt systems, and conclusions and outlook for the future. (W.H.K.)

36652 (TUBIK-19) 1969 ANNUAL REPORT OF THE INSTITUTE FOR NUCLEAR TECHNOLOGY OF THE TECHNICAL UNIVERSITY OF BERLIN. (Technische Universitaet, Berlin (West Germany). Institut fuer Kerntechnik). Feb 1970. 22p. (In German). Dep. CFSTI (U. S. Sales Only).

The 1969 annual report of the Institute for Nuclear Technology is presented. It outlines the organization of the institute, lists the contracted work done, lists the work done by students or for dissertations, cites institutional and other publications, and gives the contacts with other universities and firms. (J.S.R.)

36653 STUDY OF A COMPOSITE NEUTRON MONOCHROMATOR SYSTEM CONSISTING OF CRYSTALS WITH A GRADIENT OF THE LATTICE SPACING. Rusticheili, F. (Institut Max von Laue-Paul Langevin, Grenoble, France, CCR-EURATOM, Ispra, Italy). Nucl. Instrum. Methods; 83: 124-30(1970).

The possibility of replacing crystals with a mosaic spread by crystals with a gradient of the lattice spacing in composite neutron monochromator systems was investigated. It is shown that in connection with well collimated beams (emerging for instance from neutron guides) the crystals with a gradient of the lattice spacing offer a considerably higher intensity, for a fixed diffraction direction, than conventional crystals. This characteristic is a consequence of the fact that no limitation exists in the thickness of the crystals along the secondary ray direction. The values of the lattice spacing gradient which optimize the neutron reflectivity are calculated for several materials normally used as neutron monochromators. Some considerations are presented on the experimental techniques suitable for production of crystals with a relative variation of the lattice spacing of the order of some percent. (auth)

36654 WATER-COOLED TWIN CALORIMETER (2 Apr 1969) (Engineering Materials). (Savannah River Operations Office (AEC), Aiken, S. C.). (CAPE-2004).

2 drawings.

The water-cooled twin calorimeter measures the heat generated by Cm-244 in targets to confirm the quantity contained in the target. The targets are used in the conversion of Cm to Cf. The calorimeter consists of identical water-jacketed Cu containers and a small dual-heat exchanger encased in a stainless-steel box. Cooling water is routed through the heat exchanger and through the jacket of one container, back to the heat exchanger, and then through the jacket of the second container, coolant temperature is measured by a thermopile mounted across the water connections. Each container is thermally insulated, so that all heat liberated in the containers is delivered to the cooling water. In operation, Cm containing material is placed in one container and the temperature of the cooling water is measured. The other container is heated electrically until all cooling water passing through both jackets is at the same temperature. Electric power is measured with an ammeter and voltmeter. This power is equal to the power (in watts) dissipated by the Cm-244. Power in watts divided by 2.83 W/9 equals the Cm-244 in the slug. The calorimeter is operated with master/slave manipulators. About 45 min are required for a determination. Precision is within 25%. (For details see TID-4100 Suppl. 59.) (F.S.)

36655 PHYSICOTECHNICAL PARAMETERS OF X-RAY INTENSIFIER FOILS AND OF FLUOROSCOPIC SCREENS. Brandt, G.-A. (VEB Kali-Chemie, Berlin). Radiol. Diagn.; 10: 455-65(1969). (In German).

Calcium tungstate as well as the combination zinc sulfide/cadium sulfide were studied as photo emitters for both x-ray screens and intensifier foils in x-ray film holders. Grain size, amounts of photoactive material, binding substance, and thickness were studied at various x-ray energies. Results were depicted in 17 diagrams. (H.B.G.)

36656 FOCUS OF A REVOLVING ANODE IN AN X-RAY TUBE AS FACTOR IN THE IMAGE PRODUCING SYSTEM. Roessel, R. (VEB Roehrenwerk, Rudolstadt, Ger.). Radiol. Diagn.; 10: 447-9(1969). (In German).

Geometrical distortions are the result of the fact that x-rays do not originate from a point source. These distortions must be considered in any information theory. Therefore, actual size of the focus is measured, especially its dependence on voltage and current. In addition, the effect of utilization time is studied with respect to focus size and x-ray energy. Findings are depicted in three diagrams. (H.B.G.)

36657 QUALITY COMPARISON OF ALL IMAGE PRODUCING SYSTEMS EMPLOYED IN RADIOLOGY. Angerstein, W. (Forschunginstitut fuer Tuberkulose und Lungenkrankheiten, Berlin). Radiol. Diagn.; 10: 467-80(1969). (In German).

An aluminum and a Lucite phantom were developed for evaluation of various image producing systems in radiology. These phantoms had series of holes that varied systematically with respect to both diameter and depth. X-ray pictures of the phantoms were then evaluated as to detail and contrast. The results were depicted in 15 contrast-detail diagrams. The Jena screen camera almost corresponded to direct x-ray pictures with intensifier foils. Image intensifiers with television camera improved details while video recorders lost details with decreasing band width. The x-ray doses necessary to obtain optimal pictures are presented in two tables. (H.B.G.)

36658 TEST MODEL FOR ASSESSMENT OF IMAGE QUALITY. Schott, O.; Duemmling, K. (Siemens-Aktiengesellschaft, Erlangen, Ger.). Radiol. Diagn.; 10: 481-4(1969). (In German).

Similar to a method used in television, a plate was developed for rapid testing of an x-ray screen-image intensifier-television system. The test plate, as represented in a picture, contained various configurations and densities corresponding to that of biological objects. The test plate was rotated for checking any delays in the total system. By observation of the television screen, any misfunction of the system was quickly detected and corrected. (H.B.G.)

36659 EFFECTS OF FOCUS AND GEOMETRY ON QUALITY OF IMAGE-PRODUCING SYSTEMS IN RADIOLOGY. THE PROBLEM OF GEOMETRICAL MAGNIFICATION. Stargardt, A. (Forschunginstitut fuer Tuberkulose und Lungenkrankheite, Berlin). Radiol. Diagn.; 10: 507-13(1969). (In German).

Focal size, focus-object distance, and the distance between object and image producing systems are studied. By means of the modulation-transmission function, the applicable mathematical equations are derived and conditions for achieving optimal x-ray pictures are discussed. (H.B.G.)

36660 SECOND ORDER ABERRATION COEFFICIENTS OF LARGE DISPERSION MASS SPECTROMETER. Fukomoto, S.; Matsuo, T. (Osaka Univ.). Nucl. Instrum. Methods; 83: 58-60(1970).

A large dispersion mass spectrometer has been built for precise measurement of atomic masses. Second order aberration coefficients B_{11}, B_{12} and B_{22} of the apparatus are determined experimentally. Ion accelerating voltage and position of the angle defining slit are changed slightly and corresponding displacements of ion beam are measured at the detector. $B_{11} = 48$, $B_{22} = -73$ and $B_{12} = 37$ are obtained under the present operating conditions of the apparatus. (auth)

36661 DC COUPLED UNIVERSAL COINCIDENCE UNIT. Karolyi, Gyula. ATOMKI (At. Kut. Intez.) Kozlem.; 11: 169-73(Dec 1969). (In Hungarian).

The universal coincidence unit is a new element of the nuclear module series under development. The resolving time depends on the width of the input pulses. The 5 input stages can be arbitrarily used as coincidence or anticoincidence inputs. The output pulses are suitable for controlling scalers as well as for gating multichannel analysers. (auth)

36662 ELECTRONIC DELAY UNIT FOR EQUAL PULSES. Karolyi, Gyula. ATOMKI (At. Kut. Intez.) Kozlem.; 11: 163-7 (Dec 1969). (In Hungarian).

The presented delay unit is suitable for delaying constant-amplitude pulses. The delay is variable between 0, 1 and 20 μsec. This unit is an element of the nuclear module series under development in ATOMKI. (auth)

36663 BACKGROUND SUBTRACTION CIRCUIT PROVIDED FOR DIGITAL NUCLEONIC MEASURING DEVICES. Seifart, M. (VEB RFT Messelektronik, Dresden). Kernenergie; 13: 87-90(Mar 1970). (In German).

After giving a review of the most well-known techniques of background subtraction in digital nucleonic measuring devices, two circuits are discussed in detail. These circuits only call for a comparatively small expenditure and show the advantage to be not bound to a definite layout of the counting device. The error of subtraction arising in the two circuits is calculated in detail, based on background counts being statistically distributed or periodic. In the most favorable circuit the error of subtraction is found to be smaller than 5 per cent when gross counting rate is at least 50 to 100 per cent higher than the background. (auth)

36664 MASS SPECTROSCOPIC STUDIES ON THE MECHANISM OF IONIZATION OF ATOMS FORMED AS A RESULT OF RADIOACTIVE DECAY PROCESSES. I. Aratani, Michi; Saito, Nobufusa (Inst. of Physical and Chemical Research, Yamato, Japan). Shitsuryo Bunseki; 18: 906-19(Mar 1970). (In Japanese).

A specially designed mass spectrometer of a pulse counting mode has been constructed for studies on the chemical effect of nuclear transformations. The ion source has been examined by a beam experiment method using non-radioactive rare gas ions from an electron bombardment chamber. Measurements have been made of ion detection with 10 and 16 stage Cu-Be electron multipliers, the gains of which are 10^6 and 10^8, respectively. The results have shown that a gain of at least 5×10^4 is needed for the so-called "one to one" pulse counting. Charge spectra of recoil ions from α-emitting nuclides have also been measured and discussed in connection with the decay scheme. (auth) (NSA of Japan)

36665 INSTRUMENT FOR THE DETERMINATION OF COOLING GAS HUMIDITY IN A NUCLEAR POWER REACTOR. Jung, J. Czechoslovakian Patent 131,123. 2 Dec 1968. Filed 2 Jan 1967.

In some types of nuclear power stations, the vapor pressure of the secondary cycle is higher than the gas pressure in the reactor. If, during operation, a leak occurs between the primary and secondary cycle, i.e., in the steam generator, then water vapor at higher pressure leaks from the secondary to the primary cycle. At the same time, water vapor must not be present in the primary cycle in more than trace amounts. The patent application claims an instrument for the determination of cooling gas humidity that has the form of a measuring tube with continual inlet and outlet of the gas to be measured; a monochromatic radiation source and a detector are placed in the tube, the source being a laser with frequency corresponding to one of the absorption bands of water vapor. (NSA of Czech.)

36666 MOSFET GATE WITH 100 dB CARRIER SUPPRESSION. Moores, B. Michael; Munnings, Ron H.; Armstrong, Robin L. (Univ. of Toronto). Rev. Sci. Instrum.; 41: 1096-7(Jul 1970).

A solid-state rf gate which utilizes MOSFET's is described for use in a pulsed NMR spectrometer. The circuit was developed for use at 200 MHZ but can be used at lower frequencies. The circuit provides greater than 100 dB carrier suppression. (W.H.K.)

36667 LEADING-EDGE TUNNEL-DIODE DISCRIMINATOR. Harms, J. (Univ. of California, Berkeley). Contract W-7405-eng-48. Nucl. Instrum. Methods; 83: 221-5(1970).

A fast and highly stable leading edge pulse discriminator has been designed (50 mV sensitivity; 1.2 nsec slewing; 0.1 mV/°C threshold stability). The circuit is based on a current switch consisting of a tunnel diode and a nonlinear load; operational amplifier stabilization provides temperature stability and independence from variations of transistor parameters without adjustments. (auth)

36668 MATHEMATICAL STUDY OF SUCCESSIVE APPROXIMATION ADC'S CHANNEL WIDTH. Hrisoho, A. (Institut de Physique Nucleaire, Orsay, France). Nucl. Instrum. Methods; 83: 254-60(1970).

The influence of input and weight voltage variations on channel width is examined. To obtain a mathematical expression for the differential linearity, the channel width is treated as a function of L_m –the channel width defined by the weights only. In a second step, L_m is supposed to be variable. To avoid errors due to the nonideal stretcher and transients during weight setting, the method of supplementary tests is examined. This method leads to improvements of very fast successive approximation ADC's. (auth)

36669 REAL-TIME ISOACTIVITY CONTOUR PLOTTER FOR RECTILINEAR SCANNERS. Johnson, Philip M.; King, Robert E.; Katz, Louis L. (Presbyterian Hospital, New York. Riverside Research Inst., New York). Radiology; 96: 193-5 (Jul 1970).

An isoactivity contour plotter was developed for use with any rectilinear scanner. Operating in real time, it generates ten unambiguous isoactivity contours outlining any radioactivity distribution. Interpretation of a conventional scan is enhanced by reference to these isocontours, permitting quantitative identification of statistically significant variations in detected radioactivity levels. (auth)

36670 NOVEL TRIPLET OF ELECTROSTATIC QUADRUPOLE–OCTUPOLE LENSES WITH CORRECTED SPHERICAL A ABERRATION. Shpak, E. V.; Yavor, S. Ya.; Savin, O. R.; Kuzema, A. S. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Tech. Phys. (Engl. Transl.); 14: 1294-6(Mar 1970). Translated from Zh. Tekh. Fiz.; 39: 1720-3(Sep 1969).

A triplet of five-electrode quadrupole–octupole electrostatic lenses for prefocusing the ion beam at the input to a mass spectrometer is described. (W.H.K.)

36671 ANALOG AND HYBRID COMPUTATION APPLIED TO NUCLEAR ENERGY. Proceedings of International Symposium, Versailles, France, September 16–18, 1968. Brussels, Presses Academiques Europeennes (1969). 306p. (In French and English). (CONF-680941).

Separate abstracts were prepared for the 37 included papers. (M.O.W.)

For abstracts of individual papers see: 36479–36481, 36498–36501, 36623, 36672, 36673, 37415, 37502, 37526, 38053, 38399, 38400, 38497, 38498, 38506–38510, 38533–38536, 38554, 38615, 38617, 38619, 38621, and 38627–38631.

36672 COMPUTER INTERFACE DESIGN FOR SIMULATION AND INSTRUMENTATION IN NUCLEAR ENGINEERING. Korn, Granino A. (Univ. of Arizona, Tucson). pp 11-21 of Analog and Hybrid Computation Applied to Nuclear Energy. Brussels, Presses Academiques Europeennes (1969).

From International Symposium on Analogue and Hybrid Computation Applied to Nuclear Energy, Versailles, France. See CONF-680941.

To the nuclear engineer, digital-computer interface design is of vital and increasing importance for simulation, control, instrumentation, and data processing. Hybrid-computer linkage design deals only with a small facet of the interface world, but reflects many of its problems. This tutorial report reviews the important techniques for transferring data and control signals between digital computers and the outside world and discusses, in turn, device selection and control for a party line I/O bus, device control, sensing, interrupts and automatic data channels with direct memory access. Interfaces for iterative analog computers, for combined simulation, and for simple graphic displays are described as examples. Finally, special interfaces for random-process measurements and interfaces employing an intermediate digital processor are discussed. (auth)

36673 ANALOG DIRECT REACTIVITY METER TECHNIQUE. Dierckx, R.; Van Wauwe, A. (EURATOM–CCR, Ispra, Italy). pp 72-6 of Analog and Hybrid Computation Applied to Nuclear Energy. Brussels, Presses Academiques Europeennes (1969).

From International Symposium on Analogue and Hybrid Computation Applied to Nuclear Energy, Versailles, France. See CONF-680941.

A short survey is given of the classical solutions, used to build reactivity meters, which allow to measure reactivities down to a few pcm (1 pcm = 10^{-5} Δ k/k). An instrument, measuring reactivities as low as one hundredth of a pcm (0.01 pcm) is obtained using a backing off unit placed between detector and the circuit simulating the delayed neutron source terms. A drift of the reactivity signal has been observed. A drift free solution is obtained by a non-conventional programming of the delayed neutron simulation. The errors introduced by the applied approximations, namely the prompt jump approximation ($dn/dt = 0$) and the omission of some short lived delayed neutron groups, are studied measuring the transfer functions on a simulated coupled system: reactor–reactivity meter. (auth)

Radiation Effects on Instruments and Instrument Components

Refer also to abstract 36998.

36674 (SC-RR-70-397) TRANSIENT ANNEALING OF EFFECTS IN IRRADIATED SILICON DEVICES. Gregory, B. L.; Sander, H. H. (Sandia Labs., Albuquerque, N. Mex.). Jul 1970. 60p. Dep. CFSTI.

The annealing of radiation-produced defects in semiconductor devices is discussed briefly for ^{60}Co gamma-ray and 1-MeV electron damage, and in detail for fast-neutron damage. The effects on the reordering processes of varying the material parameters and the irradiation conditions are considered. Transient annealing of neutron damage near room temperature has been investigated for a wide variety of devices, and the data are presented in generalized form to increase their usefulness to device and circuit designers. Based on the experimental results, physical models are suggested for the reordering processes which occur during the annealing of neutron damage. Electron density is shown to be the most important factor governing the rate of transient annealing. Annealing factors are estimated for very early times (1 μsec) following neutron exposure. Suggestions are made to minimize the effects of transient annealing on devices. (auth)

36675 INFLUENCE OF ELECTRON IRRADIATION ON PARAMETERS OF GaAs PULSED DIODES. Brudnyi, V. N.; Vilisov, A. A.; Vyatkin, A. P.; Krivov, M. A.; Malyanov, S. V. (Tomsk State Univ., USSR). Izv. Vysah. Ucheb. Zaved., Fiz.; No. 4, 109-13(1970). (In Russian).

It is shown that volt-ampere characteristics of diodes obtained by various methods are, approximately, identical. The behavior of the C(U) volume during irradiation was examined using the theory developed for the surface p–n transitions and Schottky-type barrier. The diode restoration time (τ_{rest}) during large doses of $\varphi \sim 10^{16}$ el/cm^2 always increased. At smaller doses for the diodes of the Schottky barrier (weakly formed) the τ_{rest} always increased during irradiation due to the reduced concentrations of n, but for the strong-formed diodes (with parameters close to diffusion) the behavior of the τ_{rest} is determined by the distribution of impurities and the ratio between the lifetime of the non-basic carrier τ and the constant of the diode $\overline{RC}$. With the $\tau > RC$ the τ_{rest} may diminish due to diminishing τ. (R.V.J.)

36676 PHOTOEMISSION STUDIES OF INTERFACE BARRIER ENERGIES OF IRRADIATED MOS STRUCTURES. Peel, J. L. (North American Rockwell, Anaheim, Calif.); Kjar, R. A.; Eden, R. C. Appl. Phys. Lett.; 17: 3-5(1 Jul 1970).

The effects of ionizing radiation in large-geometry MOS structures were studied by use of internal photoemission techniques. Barrier heights at both the silicon-silicon dioxide and the silicon dioxide–metal (chromium) interface were measured before and after irradiation in a ^{60}Co gamma cell. It was determined that the measured barrier energy heights were considerably reduced by radioinduced oxide charge. (auth)

36677 MEASUREMENT OF THE TRANSIENT EFFECTS OF A GAMMA-FLUX ON THE ENERGY RESOLUTION OF SURFACE-BARRIER SILICON DETECTORS. Bertin, A.; Vannini, G. (Univ., Bologona. Istituto Nazionale di Fisica Nucleare, Bologna). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; 17: No. 2, 40-51 (Apr 1970).

The energy resolutions of surface barrier n-type silicon detectors counting alpha-particles were measured under the disturbance of 1.25 MeV gamma-fluxes ranging from 2.3×10^7 to 3.8×10^8 photons cm^{-2} sec^{-1} and for detectors having different total thicknesses and resistivities. The results obtained confirm the existence of a zone about 100 micron wide and external to the depletion layer of partially depleted detectors which contributes to worsen the energy resolution of the gamma-irradiated detectors by diffusion processes. It is also pointed out that the energy resolution of the detectors under gamma irradiation varies with the time constants of the amplifying circuit quite differently from what is observed in the absence of gamma irradiation. (auth)

36678 PREDICTED EFFECTS OF NEUTRON IRRADIATION ON GaAs JUNCTION FIELD EFFECT TRANSISTORS. McNichols, J. L.; Ginell, W. S. (McDonnell Douglas Astronautics Co., Santa Monica, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; 17: No. 2, 52-4(Apr 1970).

The fast-neutron-induced degradation of the properties of n-channel GaAs junction field effect transistors (JFET) is estimated and the results are compared with the effects produced in n- and p-channel silicon field effect transistors. The estimated degradation of the maximum transconductance, maximum drain current, pinch-off voltage, and cutoff frequency is based on electrical measurement data taken for fast-neutron-irradiated bulk n-type GaAs samples. It is concluded that n-channel GaAs JFET'S should be at least as resistant to fast neutrons as either n- or p-channel Si JFET's. (auth)

LIFE SCIENCES

Biochemistry, Physiology, and Molecular Biology

36679 (AEC-tr-7145) RADIOBIOLOGY. Translation of Radiobiologiya; 9: No. 6, 795-960(1969). 235p. Dep. CFSTI.

Abstracts of the papers were prepared from the original language and have appeared in NSA. (C.H.)

Basic Processes

Refer also to abstracts 36189, 36193, and 36256.

36680 UTILIZATION OF ROOT ORGANIC COMPOUNDS DURING THE REGENERATION OF LUCERNE. Hodgkinson, K. C. (Commonwealth Scientific and Industrial Research Organization, Deniliquin, Australia). Aust. J. Biol. Sci. 22: 1113-23(Oct 1969).

Organic compounds in the roots of lucerne, labeled with ^{14}C following the assimilation of $^{14}CO_2$ by the shoots 1 day prior to complete herbage removal, were subsequently lost from the roots either through respiration or translocation into new shoots for about the first 20 days of regeneration. The majority of the compounds used in these two processes were derived from the taproot. Autoradiography revealed that compounds labeled with ^{14}C 10 days prior to herbage removal were translocated from the roots into the new shoots. The contribution of accumulated organic compounds to the growth of the leaves of new shoots occurred mainly during the formation and expansion of the first-formed leaves, whereas for the stems it continued for a longer period (up to 20 days). For the first 10 days of regeneration the movement of ^{14}C-labeled compounds into stems of new shoots was independent of daylight intensity whereas the movement into leaves during this period was directly related to the daylight intensity. Export of ^{14}C-labeled photosynthates from the leaves of new shoots into the roots was measured on the sixth day and probably commenced earlier. (auth) (Australia)

36681 KINETICS OF ^{99m}Tc LABELLING OF TYROSINE. El-Garhy, M.; Megahed, Y. M.; Kassem, A. A.; Abdullah, E. (Atomic Energy Establishment, Cairo). Strahlentherapie; 139: 316-17(Mar 1970).

The conditions affecting the preparation of ^{99m}Tc-tyrosine were reviewed. The particular factors discussed in detail comprised reaction time, type of oxidizing agent and acidity of reaction medium. The results obtained were compared with those for ^{131}I-tyrosine. Yields up to 100 per cent could be achieved in a more acid medium than that of ^{131}I-tyrosine. The product purified on sephadex was identified as Mono-^{99m}Tc-iodotyrosine. (auth)

36682 ACTIVE BONE MARROW DISTRIBUTION IN THE MONKEY. Taketa, S. T. (Ames Research Center, Moffett Field, Calif.); Carsten, Arland L.; Cohn, Stanton H.; Atkins, Harold L.; Bond, Victor P. Life Sci., Part II: 9: 169-74(8 Feb 1970).

Four monkeys (Macaca mulatta) were injected intravenously with ^{59}Fe-ferrous citrate and ^{99m}Tc sulfur colloid. One hr later they were killed and the bones and other organs were prepared for scintillation counting. The erythropoietic (^{59}Fe) and reticuloendothelial (^{99m}Tc) activities, expressed as percent of total bone activity, were highest in the vertebrae which contributed about 33% of the total skeletal marrow activity. The lower limbs contributed 20%, the upper limbs 12%, the hip bones 12%, the skull and mandible 11%, the ribs and sternum 6%, and the scapulae and clavicles 4%. The percent of administered dose of ^{59}Fe in the skeleton was about ten times higher than that of ^{99m}Tc. However, the ^{99m}Tc activities in the spleen and liver were significantly higher than those of ^{59}Fe. A table is presented to show comparative erythropoietic bone marrow distribution in monkeys, dogs, rats, mice, and man. (H.L.W.)

Metabolism, Physiology, and Toxicology

Refer also to abstracts 36744, 36747, and 36827.

36683 (JUL-603-ST, pp 185-6) DOSIMETRY FOR PERSONNEL AND LOCATION: METHODS FOR THE ANALYSIS OF THORIUM AND AMERICIUM IN URINE. Jacobs, H.; Bayer, D.; Jaeckel, M. (Kernforschungsanlage, Juelich (West Germany). Zentralabteilung Strahlenschutz). (In German).

A chemical method is described for the determination of thorium in urine. Each analysis requires about four hours. The sensitivity is one microcurie per liter. For the determination of americium in urine, an analytical procedure is briefly described. The technique is still considered experimental. (H.B.G.)

36684 RADIOECOLOGY OF ^{137}Cs AND ^{90}Sr IN A FOREST. Yamagata, Noboru (Inst. of Public Health, Tokyo); Matsuda, Shunji; Chiba, Morito. J. Radiat. Res.; 10: 107-12(Sep-Dec 1969).

Quantitative distribution pattern of ^{137}Cs and ^{90}Sr was determined in a forest area after preliminary studies in different sites. The highest concentration of both radionuclides was found in the fallen leaves and this can be reasonably explained by the fact that the fallout rates were the highest three years before this observation. About 80% and 63% of the total deposition respectively of ^{137}Cs and ^{90}Sr were found in the upper 5 cm layer of soil, 18% and 23% in the vegetation, of which 11.4% and 10.7% were in the fallen leaves. Root absorption of ^{90}Sr by pine tree and shrub was considered at least twice that of ^{137}Cs. (auth)

36685 A STUDY ON THE DISTRIBUTION OF ^{95}Zr-^{95}Nb ADMINISTERED SUBCUTANEOUSLY TO RATS: COMPARISON BETWEEN YOUNG AND ADULT RATS. Ishinishi, Noboru; Morishige, Toshiko (Kyushu Univ., Fukuoka). J. Radiat. Res.; 10: 101-6(Sep-Dec 1969).

Following a single subcutaneous injection of ^{95}Zr-^{95}Nb to young and adult rats, the concentration of the nuclides in several organs was studied during the observation period of 63 days. The concentration in the tibia, lungs, liver, kidneys and spleen of the young rats was much higher than in the adult rats. The concentration in the tibia, was the highest both in the young and in the adults for all the organs studied. Moreover, in the tibia, ^{95}Zr-^{95}Nb were retained longer than in other organs. Thus, if ^{95}Zr-^{95}Nb enter the body fluid through any route, they will be deposited mainly in the bone and may possibly cause radiation injury to the bone marrow. (auth)

36686 EFFECT OF LITHIUM SALTS ON UPTAKE OF ^{125}I BY RAT THYROID GLAND. Hullin, R. P.; Johnson, A. W. (Univ. of Leeds, Yorkshire, Eng.). Life Sci., Part II: 9: 9-20(8 Jan 1970).

It was shown that lithium salts at dosage levels/kg. commensurate with that given to patients had marked effects on the uptake of ^{125}I by rat thyroid. (F.M.M.)

36687 UPTAKE MECHANISM OF ABSORPTION OF RADIOSTRONTIUM IN RATS. Popelka, M. (Lekarska Fakulta, Olomouc, Czech.). Sb. Ved. Pr. VLVDU Hradci Kralove; 41: 23-42 (1969). (In Czech).

Strontium transport through the duodenal epithelium was studied. The time-course of the accumulation and desorption of strontium by the duodenum was determined. The excretion of amino acids, phosphates and proteins from a part of the duodenum was also measured. A possible binding of radiostrontium to these metabolites was considered. In order to verify the strontium transport by amino acids, single chelating groups were blocked succesively. No chelating groups that affected the accumulation of strontium were found on the surface of the duodenum. Metabolic inhibitors were also used for studying the metabolic pathways. The results can be summarized as follows. The duodenum represents the active adsorbent. Strontium is bound to an amino acid complex during transport. Transport is suppressed by phosphates and chelating agents having greater stability constants. Inside the duodenum wall strontium is utilized by binding to proteins. Physical adsorption takes place as well. The inhibition of metabolic pathways by which amino acids are formed and the influence of membrane permeability decrease resorption. (auth)

36688 THE DECREASE OF STRONTIUM ABSORPTION BY MEANS OF THE ACTIVATED BARIUM SULPHATE IN FRACTIONATED AND CONTINUOUS CONTAMINATION. Knajfl, J.; Smid, A. Sb. Ved. Pr. VLVDU Hradci Kralove; 41: 67-82(1969). (In Czech).

The problem of strontium ($^{89,90}Sr$) is considered to be the leading one in radiotoxicology. In some experiments, animals were given radiostrontium per os in fractionated doses. It was shown that all the strontium was incorporated in the bones during 4 days following an interruption of its inflow. The possibility of decreasing strontium absorption from the gastrointestinal tract was considered. Effects of barium sulphate, alginates and many other substances were studied. Activated barium sulphate (ABS) is one of the most effective substances for decreasing the absorption of radiostrontium. ABS can be used in the case of a single peroral contamination with radiostrontium and the time factor does not influence

its efficiency significantly until 2 hours following the radionuclide administration in rats. Besides, two important properties are present, namely, a high selectivity for strontium ions in the presence of calcium, and there is no dependance of effect on pH. The experiments were carried out in several species of animals (mice, rats, cats and rabbits). The retention of radiostrontium was decreased on an average of 85 to 90%, when ABS was given 10 to 30 minutes following contamination. In man the same effect was observed. (F.M.M.)

36689 TESTING OF THE ELIMINATION EFFECTIVENESS OF CHELATING AGENTS IN VITRO. Slouka, V. Sb. Ved. Pr. VLVDU Hradci Kralove; 41: 149-61(1969). (In Czech).

The filterability of lanthanons from the blood serum in the presence of chelating agents is a good indicator of their elimination effectiveness in vivo. When ^{141}Ce is used as a chelate with NTA or EDTA, these relatively weak chelates cannot prevent the binding with blood serum proteins. 1 ml of the radioactive solution in a cellulose bag was dialysed against 100 ml of isotonic saline for 20 hours. In another experiment, the filterability of radiocerium from the serum obtained from rats 30 minutes after intravenous injection of $^{141}CeCl_3$ was studied in the presence of NTA, EDTA and DTPA. No differences were found concerning the binding in vitro and in vivo. Equilibrium dialysis was used also for the study of radiocerium binding in liver homogenates. The difference in binding corresponded to the elimination effectiveness at 3 days after contamination and DTPA treatment of rats. Similar results were obtained after the addition of radiocerium or radiocerium with DTPA to liver homogenates. The filterability after DTPA was 92 to 96% against 12% in control series. The lower in vitro effect of DTPA in experiments with ^{141}Ce at pH 8 may be attributed to partial hydrolysis of ^{141}Ce. The filterability of ^{141}Ce from liver homogenates proved to be also a good measure of the optimum dose of perorally administered DTPA and useful for the investigation of the role of time interval on the elimination effectiveness DTPA. Both these in vitro tests may be used for the testing of the relative elimination effectiveness of chelating agents without extensive time and material consuming experiments in vivo. (auth)

36690 THE BINDING OF RADIOCERIUM TO BLOOD SERUM PROTEINS STUDIED BY DIALYSIS. Slouka, V.; Bathova, M. Sb. Ved. Pr. VLVDU Hradci Kralove; 41: 105-23(1969). (In Czech).

Equilibrium dialysis was used to study the diffusibility of ionic and colloidal forms of radiocerium with different amounts of the isotopic carrier in the range of 10^{-3} to 10^{-11} M. At concentrations lower than 10^{-6} M colloidal aggregates are formed in a TRIS-acetate buffer at pH 7, 4, at higher concentrations of the carrier a hydrolysis with the formation of larger aggregates takes place. At concentrations lower than 10^{-6} M a substantial amount of radiocerium is absorbed onto the cellophane casing. A decrease of diffusibility at pH 8 appears at a concentration of one order of magnitude earlier than at pH 4. Dialysis of the solutions of $^{141}CeCl_3$ in TRIS-acetate buffer of pH 3 to 9 incubated 30 minutes with blood plasma, blood serum, serum albumin, gamma-globulin, isotonic saline or with a TRIS-acetate buffer showed that the diffusibility with proteins is lowest at pH 5 to 6 where the greatest binding with proteins may be expected. There were no differences between the binding in blood plasma and blood serum; albumin and gamma-globulin bound nearly the same amount as the whole serum. The results of experiments with other lanthanons (La, Pr, Yb) correspond with those from radiocerium experiments. A further experiment showed the loss of filterability of radiocerium with a serum ultrafiltrate and with a synthetic serum ultrafiltrate as well. The absence of phosphate ions in a synthetic serum ultrafiltrate led to an increase of diffusibility of one order of magnitude. Hence it follows that the serum ultrafiltrate contains low-molecular substances binding lanthanons. A part absorbing UV light (254 nm) may be attributed to amino acids, the other part is represented by phosphates with which lanthanons form insoluble precipitates. The identification of UV-absorbing materials is being studied. (F.M.M.)

36691 SECRETION AND DISTRIBUTION OF ^{131}I IN MILK FROM DAIRY COW AFTER INTRAVENOUS ADMINISTRATION OF A SINGLE DOSE. Ohmomo, Yoichiro; Saiki, Masamichi (National Inst. of Radiological Sciences, Chiba, Japan). Radioisotopes (Tokyo); 19: 282-5(Jun 1970).

The distribution of ^{131}I in milk and the secretion into milk from lactating Holstein cows after a single intravenous administration were investigated. It was found that about 26% and 61% of dosed ^{131}I were recovered during the 6 days following adminstration from milk of Holstein (A) and (B) respectively. About 2% and 20% of ^{131}I were found in fat and protein fractions respectively and no regular variation was observed in the distribution pattern as a function of time after administration. It was concluded that the combined system of ion exchange treatment and CCl_4 extraction is acceptable as a rapid and convenient method for the determination of ^{131}I in milk. (F.F.M.)

36692 EFFECT OF DTPA ADMINISTRATION ON THE INCORPORATION OF ^{90}Y, PRODUCED AS DECAY PRODUCT OF ^{90}Sr. Steinbach, Karl-Heinz; Weber, Elisabeth; Giss, Marta (Heiligenberg-Institut, Ger.). Strahlentherapie; 139: 318-22 (Mar 1970). (In German).

The efficiency of DTPA-treatment on the incorporation of ^{90}Y, daughter of ^{90}Sr, in the skeleton was studied in function of age and sex of white rats and of the incorporation time elapsed. The elimination of ^{90}Y from the femur resulting from daily DTPA-administration rapidly diminished in function of time elapsed. At the first day 70% can be eliminated but only 10% at the 16th day, when compared to controls. The efficiency also decreased with age of the animal: in an 8 week old animal the amount excreted is twice that excreted from a 32 week old animal. The efficiency is also 20% higher in females than in males. (auth)

36693 RADIOACTIVE IODOCOMPOUNDS IN THE NEURAXIS OF RANA PIPIENS DURING METAMORPHOSIS INDUCED WITH ^{125}I-THYROXIN. Dratman, M. B.; Jacob, G.; Dacou, C. (Woman's Medical Coll. of Pennsylvania, Philadelphia). Confin. Neurol.; 31: 238-46(1969).

Metamorphosis was induced in Rana pipiens tadpoles by means of daily treatment with ^{125}I-thyroxine and the CNS and other tissues were studied at intervals throughout the experiment. Radioautographic studies, previously reported, revealed the accumulation of thyroxine iodine in regions of brain and spinal cord considered to be actively involved in neural adjustments during metamorphosis. Parallel biochemical investigations are reported that indicate the presence of labeled iodide, iodotyrosines, iodothyronines, and iodoprotein in tissue homogenates. Metamorphic progress was correlated with increasing concentration of extrathyroidal iodoprotein; since this metabolite would survive fixation and preparation for radioautography, it qualifies for consideration as the molecular form of thyroxine iodine observed to increase progressively in correlation centers of the CNS. The labeled proteins were treated with proteolytic enzymes, in an effort to gain insight into their composition and biogenesis. Paper chromatography of the hydrolysates revealed labeled iodide, iodothyronines, plus small amounts of iodotyrosines. These results raise questions concerning present concepts that iodoproteins are iodination products incidental to the enzymatic deiodination of the thyroid hormones, and suggest that these metabolites may be dynamically related to differentiation. (auth)

36694 SOME USES OF ISOTOPES IN METABOLIC STUDIES WITH SOIL MICRO-ORGANISMS. Stanley, P. E.; Nicholas, D. J. D. (Adelaide Univ.). At. Energy Aust.; 12: 11-20(Jul 1969).

Metabolic studies with soil micro-organisms using tagged compounds are described and examples of their applications to specific problems are discussed. These include the uses of ^{15}N and ^{13}N in studies with nitrogen-fixing bacteria; ^{35}S and ^{18}O labelled inorganic sulfur compounds to follow oxidation of sulfide and the reduction of sulfate; the $^{14}CO_2$ fixation process in chemoautotrophic bacteria; ^{3}H, ^{14}C and ^{32}P to follow the incorporation of nucleosides and nucleotides into nucleic acids; ^{32}P in studies with the esterification of inorganic phosphate into adenosine triphosphate during respiration; and the identification of metals (^{99}Mo, ^{59}Fe, ^{58}Co) in enzymes. (Australia)

36695 THE IN VITRO UPTAKE OF TRITIATED OESTRADIOL BY THE OVIDUCT OF IMMATURE AND LAYING CHICKENS. Cecil, Helene C.; Bitman, J.; Shaffner, C. S. (Univ. of Maryland, College Park). Acta Endocrinol.; 63: 265-74(1970).

The oviduct of the immature chick had a special affinity for oestradiol during in vitro incubation with tritiated oestradiol. All anatomical portions of the oviduct concentrated 3-6 times more radioactivity than other body tissues. When the immature birds were pretreated with nonlabelled oestradiol, the ability of the ovary, liver and muscle to concentrate ^{3}H-oestradiol was unaffected. In contrast, accumulation of radioactivity by oviducts from pretreated birds was reduced to a level comparable to other body tissues. The oviducts from nonlaying hens were able to accumulate more oestradiol per unit of weight than the oviducts from laying hens. Presumably the laying hen had a source of endogenous oestrogen which reduced the ability of the oviduct to accumulate ^{3}H-oestradiol from the incubation mixture. (auth) (Denmark)

36696 MEASUREMENT OF ^{212}Pb LOSS RATE FROM HUMAN LUNGS. Hursh, J. B.; Mercer, T. T. (Univ. of Rochester, N. Y.). J. Appl. Physiol.; 28: 268-74(Mar 1970).

Experiments were performed in which four human subjects were administered ^{212}Pb by mouth inhalation and by intravenous injection. Blood, urine, and fecal samples were collected. Lead-212 inhaled on natural aerosols showed lung depositions of 27 to 62%,

the amount depending on well-characterized aerosol size differences. The loss rate from the lung measured by in vivo γ counting as corrected for extralung activity in the lung survey field had a half-time of from 10.5 to 11.5 hr. Twenty-four hour urinary lead excretion after intravenous injection was from 2.6 to 6.6% dose. Fecal collections (34 to 48 hr) yielded 0.2 to 2.7% dose. (auth)

36697 PROBLEMS OF EXCRETION ANALYSIS AFTER A VARIABLE CHRONIC CONTAMINATION BY RADIOSTRONTIUM. Neruda, O.; Hradil, J. (Purkyne Univ., Hradec Kralove, Czech.). Sb. Ved. Pr. VLVDU Hradci Kralove; 41: 43-65(1969). (In Czech).

The methods and purpose of the determination of radiostrontium in human body after a nuclear war are reviewed. From the calculations of the absorbed dose after ingestion of fission products it was shown that bone absorbed the greatest dose if the fission mixture had been older than 30 days. It is assumed that the determination of body-burden of ^{89}Sr and ^{90}Sr will be found from studying the absorbed dose in bone. As ^{89}Sr and ^{90}Sr are beta emitters, the measurement of body-burden using a whole-body counter is very difficult. The only possible method is the application of excretion analysis, that is, measurement of urine activity. The mean retention and excretion curves of strontium in a human body were constructed and their deviations were considered. The values represent the percent of activity absorbed from the gastrointestinal tract. Various procedures of mathematical treatments with urinary activity of ^{89}Sr and ^{90}Sr are described to obtain the body-burden of these radioisotopes. It is assumed that the most effective method of assessment of biological effects from ^{90}Sr after a nuclear war is a long-term measurement of activity plants, foods and water. (F.M.M.)

Radiation Effects

Refer also to abstracts 36209, 36267, 36831, 36844, and 38512.

36698 (NYO-3893-15) ULTRAVIOLET LIGHT EFFECTS ON NUCLEIC ACID FORMATION AND GENETIC EVENTS IN BACTERIA. Three Year Comprehensive Report. Doudney, C. O. (Albert Einstein Medical Center, Philadelphia, Pa. Dept. of Genetics). Apr 1970. Contract AT(30-1)-3893. 48p. Dep. CFSTI.

When Escherichia coli H/r cells were exposed to 400 ergs/mm^2 of ultraviolet light and incubated without arginine, degradation of RNA and of ribosomes occurred. Under these conditions the ribosomes remained stable for one hour but rapid breakdown of the ribosomes occurred within two hours. The presence of arginine in the medium prevented most of the breakdown. Most of the damage was not photoreversible. Studies on the effects of acriflavine on uv-damaged bacterial cells were conducted. Results showed that concentrations of acriflavine that do not interfere with RNA synthesis in nonirradiated bacteria decrease the formation of RNA in uv-damaged bacteria. This phenomenon was used to study the recovery of normal capacity to form RNA in acriflavine by bacteria damaged by uv light. Experiments showed that photoreversible pyrimidine dimers in DNA were responsible for postradiation effects of the dye on RNA formation. Results suggested that the process of dark repair which results in restoration of the DNA to its normal state also results in restitution of the capacity for normal formation of RNA so that the dye is unable to affect this process. It was found that acriflavine prevented restoration of DNA replication after uv exposure even after photoreversal treatment. Studies were also conducted on effects of hydrogen peroxide on survival and mutation in uv-exposed and photoreactivated bacteria; photoreversibility of streptomycin resistance mutations in hcr$^+$ and hcr$^-$ strains of E. coli; effects of nalidixic acid on loss of photoreversibility of suppressor mutations; correlation of lethal damage with loss of photoreversibility in streptomycin resistance mutations and mutations for tryptophan independence; role of dimer excision in inactivation of DNA replication by ultraviolet radiation; and effects of amino acid starvation on the DNA replication cycle. (H.L.W.)

36699 (NYO-3893-16) ULTRAVIOLET LIGHT EFFECTS ON NUCLEIC ACID FORMATION AND GENETIC EVENTS IN BACTERIA. Annual Progress Report. Doudney, C. O. (Albert Einstein Medical Center, Philadelphia, Pa. Dept. of Genetics). Apr 1970. Contract AT(30-1)-3893. 6p. Dep. CFSTI.

Studies were conducted on photoreversibility of uv-induced mutations and lethality in Escherichia coli. It was found that loss of photoreversibility with postirradiation incubation of uv-induced mutations for streptomycin resistance and lethal damage occurred during the first 20 min of incubation and was unaffected by the absence of tryptophan with an amino acid-requiring substrain or by the absence of thymine with a thymine-requiring substrain but was blocked by dinitrophenol. Loss of photoreversibility of uv-induced lethality and damage to DNA replication were studied. Effects of acriflavine on mutation frequency following ultraviolet radiation were investigated. The rates of DNA replication relative to unirradiated controls were calculated for various doses of uv in amino acid-starved bacteria. Studies on photoreversibility of dark repair blockage of DNA synthesis showed that with low doses of uv this inhibition was eliminated by photoreversal treatment. (H.L.W.)

36700 EFFECTS OF X IRRADIATION ON THE CONTENT OF PROTEINS IN THE BLOOD SERUM OF ADRENALECTOMIZED PREGNANT RATS AND ON THE SKELETAL SYSTEM OF THEIR OFFSPRING. Sakanyan, S. Sh.; Adamyan, T. V.; Torosyan, S. E.; Mikaelyan, M. G. Biol. Zh. Arm.; 21: No. 7, 38-43(1968). (In Russian).

Experiments were conducted on white pubescent female rats (K) divided into three groups. The K1 group was subjected to unilateral, and the K2 group to bilateral adrenalectomy (AE). On the tenth day of pregnancy, half of each group (KAE) was x-irradiated to a dose of 30R. The second half was not irradiated and served as a check on AE. On group K3 observations of the natural course of pregnancy were carried out. The results of the experiment showed a shift in the general proteins and in the protein fractions of the blood in all members of groups K and morphological changes in the skeletal system of their offspring. The experiments showed that AE by itself caused a short-term increase in the quantity of albumins and a reduction of gamma-gloublins in the blood of pregnant rats. X-irradiation (30R) of AE pregnant rats, applied during the period of organogenesis in the offspring, caused a reduction in their blood alpha- and gamma-globulins, and in 20 to 25% of the offsprings, a pronounced deformation of the bones of the skull and thoracic cage and curvatures of the thoracic and tail vertebrae. (tr-auth)

36701 ACTIVATION OF MYOSIN-ATPASE BY IRRADIATED HISTIDINE. Ueno, Akiko (National Inst. of Radiological Sciences, Chiba, Japan). J. Radiat. Res.; 10: 151-64(Sep-Dec 1969).

Activation of myosin-ATPase by irradiated histidine was studied. The kinetic constant and the optimum pH for the activated enzyme were found to be different from those of non-activated enzyme. An activating agent was separated from the irradiated histidine solution by column chromatography on an ion-exchange resin. From its chemical properties and spectral characteristics, this was first assumed to be hydroxyhistidine. However, a peroxide that is more effective in activating the enzyme was also obtained from histidine on irradiation. Oxygen is needed for the production of this peroxide. Based on the studies of its sulfhydryl reactivity and heat stability, it was concluded that the peroxide concerned was not hydrogen peroxide, but presumably hydroxyhydroperoxide of histidine. From comparative studies on the activating effect on myosin of irradiated histidine and other sulfhydryl reagents, it was confirmed that irradiated histidine attacks a sulfhydryl group that is concerned with the conformation of myosin molecules, leading to an activation of myosin-ATPase. (auth)

36702 EFFECT OF RNA ON CONTENT AND RENEWAL OF ATP IN LIVER WITH RADIATION INJURY. Sopin, E. F.; Tsudzevich, B. O. (Shevchenko Univ., Kiev). Ukr. Biokhim. Zh.; 42: 31-4(1970). (In Ukrainian).

The content of ATP decreases in the liver after total x-irradiation of guinea pigs in a dose of 500 R, but the intensity of renewal increases on the 1st, 3rd, 7th, 10th day. Yeast RNA favors a rise in the ATP content of the liver in irradiated guinea-pigs and has a stabilizing effect on the intensity of ATP and inorganic phosphorus renewal. A long duration administration of yeast RNA to the normal animals results in increasing ATP in the liver (on the 3rd and 10th day) as well as in increasing the intensity of ATP and inorganic phosphorus metabolism in all the times under investigation. Yeast RNA being administered, the duration of life of the guinea-pigs after irradiation increases up to 15 to 20 days. The control animals as a rule die in 10 to 12 days. (auth)

36703 EFFECT OF UV IRRADIATION ON AMINO ACID COMPOSITION OF CALF SKIN PROTEINS. Golovach, V. M.; Ratich, I. B. (Research Inst. of Physiology and Biochemistry of Agricultural Animals, Lvov, USSR). Ukr. Biokhim. Zh.; 42: 35-8(1970). (In Ukrainian).

By means of paper chromatography the percentage content of some amino acids of skin proteins was investigated in ordinary calves as well as in those sheared and placed under irradiation by the mercury quartz lamps. It is established that ultra-violet irradiation of animals in a dose of 190 MR·h/m^2 causes only an inconsiderable decrease in histidine percentage. As to other amino acids under study—cystine, lysine, arginine, sum of asparaginic acid, glycine, serin, glutamic acid and threonine, alanine, tyrosine, valine with methionine, phenylalanine, leucine with isoleucine, their percentage content was not essentially changed. (auth)

36704 REPAIR OF ULTRAVIOLET-INDUCED DAMAGE IN TRANSFORMING DNA OF BACILLUS SUBTILIS. Munakata, Nobuo (Tokyo Univ.). Jap. J. Genet.; 45: 1-9(Mar 1970).

UV damage induced in the DNA of uvr or uvs strains of Bacillus subtilis was repaired in uvr recipient cells, but no such repair occurred in uvs cells. Post-irradiation repair of UV damage induced in the DNA of the uvr strain was inferred from the increase in extractable transforming activity observed during post-irradiation incubation carried out before assaying with uvs recipient strains. No post-irradiation restoration of UV-irradiated transforming DNA was observed in uvs cells. Strain uvs-80 was able to excise thymine dimers from the DNA as did the uvr strain but lost extractable transforming activity rapidly during post-irradiation incubation. (auth)

36705 RESPONSE OF CELLS TO HIGH-INTENSITY PULSED RADIATION AND POSSIBILITIES FOR MEASURING OXYGEN DIFFUSION TIMES IN CELLS. Epp, Edward R. (Sloan-Kettering Inst. for Cancer Research, New York). Trans. N. Y. Acad. Sci., 32: 253-61(Feb 1970).

Results of a double-pulse experiment to measure oxygen diffusion time in cells are postulated and graphs are presented to show postulated results. A diagram is presented to show the arrangement for an experiment on determining oxygen diffusion times in Escherichia coli cells irradiated with high intensity double-pulsed electrons. Doses of several hundred kilorads per pulse were used. Figures showing survival curves of Escherichia coli for various inter-pulse times with initial oxygen concentrations of 4.1% and 8.5% are presented. Experimental results show evidence for increased amounts of oxygen rediffused into cells in times measured in microseconds or milliseconds. These results agree with postulated results. The extrapolation of results to mammalian cells is discussed. (H.L.W.)

36706 STUDIES OF ^{85}Sr KINETICS IN IRRADIATED RATS. Vondracek, V. Sb. Ved. Pr. VLVDU Hradci Kralove; 41: 3-22 (1969). (In Czech).

The kinetics of radiostrontium after whole-body irradiation with 400 R (^{60}Co) was investigated in mature male rats. In the irradiated rats a tracer amount of ^{85}Sr was injected immediately after irradiation. The test solution was given orally and intravenously. The rats were sacrificed at various intervals after the administration of the isotope and the bones collected and analysed for their ^{85}Sr content. Radiostrontium retention in vivo was determined by whole-body counting. The method of Samachson was employed to quantify the absorbed amount of ^{85}Sr from the digestive tract. It was shown that the bone content of ^{85}Sr increased only in irradiated rats dosed orally. The whole-body measurements of radiostrontium retention gave similar results. The calculation of absorbed amount of ^{85}Sr in the irradiated rats showed the increased absorption of radiostrontium. In the 1st week the excretion of radiostrontium in urine in irradiated rats dosed orally was not changed being compared with control animals. No differences in ^{85}Sr bone content and body retention were found between irradiated rats dosed intravenously and control animals. Probably the mechanism leading to increased radiostrontium absorption and its bone accumulation in irradiated rats is pylorospasm, decreased intestinal motility and passage. It was concluded that bone deposition of orally administered radiostrontium in an irradiated organism is greater than in a non irradiated one. This higher level of radiostrontium accumulated in bones increases the radiation damage to hemopoiesis. (auth)

36707 BLOOD SERUM PROTEIN FRACTIONS IN HYPOTHYROSIS CAUSED BY RADIOIODINE. Neimark, A. I. (Altai Medical School, USSR). Med. Radiol.; 15: No. 2, 48-52(Feb 1970). (In Russian).

Hypothyroidism caused by the lowered activity of the thyroid gland, affects the metabolic rate and the functions of the main organs and changes the protein fractions of the blood serum. This problem was investigated by determining the total protein content and the protein fractions in the blood of human patients and of experimental animals in cases of hypothyroidism due to the effects of ^{131}I. The total protein content was determined spectrophotometrically, the protein fractions by paper electrophoresis in a medinal-veronal buffer at pH = 8.6. The hypothyroidism was induced by injecting a 0.3 mCie solution of ^{131}I solution per kg of body weight into healthy rabbits, after having determined the original protein content and the protein fractions of the blood. The results revealed that patients suffering from hypothyroidism caused by radiation therapy exhibited marked changes in the protein formula of the blood: the albumin level was reduced and the globulin level was increased, resulting in a reduction of the albumin-globulin coefficient. In the animal experimentation series, a two-stage change was noted: after 1 week, the albumin level was reduced and the α_1 and α_2 globulin content was increased. After the second month the albumin concentration started to rise, accompanied by a corresponding decrease of the α_1, α_2 globulin content; during all this time the γ globulin level was higher than at the start. (TTT)

36708 STUDIES ON THE CORRELATION OF THYROIDAL FUNCTION AND SIZE TO THYROXINE CONTENT OF SERUM. Braedel, H. U.; Kaschani, D. (Staedtische Krankenanstalte, Ludwigshafen am Rhein, Ger.). Fortschr. Geb. Roentgenstr. Nuklearmed.; 112: 680-6(May 1970). (In German).

Thyroxine determinations were carried out in 169 patients in a thyroid center, including pregnant women and women taking estrogens. The limits of variation and average values for various grades of activity and size of the thyroid gland were obtained. The relatively high average values in patients with a diffuse struma were striking. Possible changes in the composition of thyroxin-binding proteins were discussed. There was overlap between normal and excessive function. Thyroxin values were adjusted for patients on estrogens. High values during pregnancy are less pronounced towards the end of term. Serum thyroxine values after radio-iodine treatment are given. (auth)

36709 EFFECTS OF LOCAL LIVER IRRADIATION IN RABBITS ON THE DETOXIFICATION CAPACITY BY COUPLING WITH GLUCORONIC ACID. Birzle, Hermann; Beck, Kurt; Nusselt, Lothar (Univ., Freiburg i. B.). Strahlentherapie; 139: 347-53(Mar 1970). (In German).

The effect of single or fractionated x irradiation on the detoxication function of the liver was studied in rabbits. The synthesis of glucuronic acid after administration of N-acetylparaaminophenol was unchanged after 1000 R, but markedly decreased after fractionated treatment of 20 x 300 R. (auth)

36710 ULTRASTRUCTURE CHANGES IN THE BRAIN OF GUINEA PIGS AND RATS DURING LATENT PERIOD OF RADIATION REACTIONS. Lierse, W.; Franke, H. D. (Univ., Basel, Univ., Hamburg). Fortschr. Geb. Roentgenstr. Nuklearmed.; 112: 151-68(Feb 1970). (In German).

Changes in the ultra structure in the brains of guinea pigs and rats were observed during the early period following a single irradiation, one to fourteen days after 100—4,000 R, and during the latent period, one to fifteen months after 100—750 R. During the early period, there is occasional focal edema in the astrocytes and their mitochondria. In the latent period transformation of mitochondria to lysosomes is observed. In addition phagosomes at early and late stages of intraplasmic myelin absorption may be observed. These changes explain phasic changes in the levels of acid phosphatase. Granular and fibrillary elements appear in the astrocytes and ganglion cells. These are interpreted as signs of latent cell degeneration and may lead to local necrosis. Myelin sheaths become demyelinated by the action of mononuclear cells, similar to the findings in experimental allergic encephalomyelitis. (F. St.)

36711 INVESTIGATIONS OF COMBINATION INJURIES. DISTURBANCE OF ANTIBODY FORMATION IN MICE CHALLENGED BY BURNS AND WHOLE-BODY RADIATION. Messerschmidt, Otfried; Langendorff, Hanns; Boemer, Hubert (Univ., Freiburg i. B.). Strahlentherapie; 139: 354-61(Mar 1970). (In German).

Synthesis of agglutinines was inhibited during the first seven days after a burn wound in mice. During the second week after immunization, an overshooting synthesis of hemagglutinins was noted in the burned animals. When mice were irradiated, synthesis of antibodies was much lower than after burning. The inhibition of agglutinin formation is particularly pronounced when irradiation and immunization is carried out at the same time; it is less pronounced when irradiation is done four days after immunization. The perturbation of antibody formation after combined lesions can not be distinguished from the one caused by irradiation alone. (auth)

36712 HOWELL JOLLY BODIES IN NORMOBLASTS OF SUBJECTS EXPOSED TO THE HAZARD OF SMALL DOSES OF IONIZING RADIATION. Novakova, E.; Nosek, J. Cas. Lek. Cesk.; 108: 318-20(1969). (In Czech).

The number of bone marrow normoblasts containing Howell Jolly bodies was investigated. A group of underground workers, mining radioactive raw materials and a group not exposed to this hazard were compared, and shown to be very different. The control group showed on average 5.3 ± 2.2 cells with Howell Jolly bodies 5,000 normoblast, representing 1.06% of the total number of normoblasts. The miners group showed 9.3 ± 3.6 cells with Howell Jolly bodies per 5,000 normoblasts, representing 1.86% of the total number of normoblasts. The technique of detection of Howell Jolly bodies in normoblasts is to stain bone marrow

smears panoptically as recommended by Unna Pappenheim. Feulgen's method was not used routinely, because it is unreliable. (Excerpts Med.)

Immunology

Refer also to abstracts 36807 and 36841.

36713 (ANL-Trans-832) DISTRIBUTION PATTERNS FOR RADIOACTIVE RARE-EARTH ELEMENTS. Moskalev, Yu. I.; Zalikin, G. A.; Stepanov, V. S. Translated for Argonne National Lab., Ill., from Russian report. 40p. Dep. CFSTI.

Data are summarized from a number of studies on the metabolism of radioactive rare earth elements in laboratory animals (dogs, rats, and others), including ^{144}Ce, ^{165}Dy, ^{169}Er, ^{152}Eu, ^{154}Eu, ^{159}Gd, ^{166}Ho, ^{140}La, ^{177}Lu, ^{147}Nd, ^{147}Pm, ^{143}Pr, ^{153}Sm, ^{160}Tb, ^{170}Tm, ^{91}Y, and ^{175}Yb. The studies showed that after intravenous introduction of their simple salts, rare-earth radioactive isotopes leave the blood rather rapidly and are collected in the basic organs of deposition, the skeleton, liver, and kidneys. As the atomic weight of the element increases there is an increase in the quantitative deposition of radioactivity in the skeleton and a decrease in the liver. Elimination of rare-earth radioactive isotopes from mammal organs is accomplished basically through the gastrointestinal tract. The radioactive isotopes of rare-earth elements are practically not absorbed from the gastrointestinal tract and are only slowly and incompletely absorbed from subcutaneous and muscle tissue. Rare-earth nuclides introduced by inhalation are slowly absorbed from pulmonary tissue. The distribution of radioactive rare-earth elements in mammal organs is independent of the path of entry and the basic organs of deposition continue to be the skeleton, liver, and kidneys. As the pH of the starting solution is increased, the rare-earth nuclides are predominantly deposited in organs rich with reticulo-endothelial elements (liver spleen, bone marrow), and there are reduced quantities in the skeleton and kidneys. The capability of complex-forming agents to accelerate the elimination of rare-earth elements from the organism decreases with increasing solution pH. Isotopic carriers retard the absorption of rare-earth elements from subcutaneous tissue, promote the deposition of radionuclides in organs rich with reticuloendothelial elements, and significantly reduce the elimination of radioactivity through the gastrointestinal tract. Rare-earth elements are absorbed through unimpaired mammal skin, absorption occurring predominantly in the first hours after the preparation is applied to the skin. (70 references) (C.H.)

36714 IMMUNOSUPPRESSIVE ACTION OF PHYTOHEMAGGLUTININ. EFFECT ON PERITONEAL MACROPHAGES. Chan, P. C. Y. (Palo Alto Medical Research Foundation, Calif.). Int. Arch. Allergy Appl. Immunol.; 36: 486-96(1969).

It has been demonstrated that the immunocompetence of mouse peritoneal cells was not affected by treatment with plant hemagglutinin (PHA) as measured by their ability, after in vivo erythrophagocytosis, to elicit antibody synthesis in syngeneic recipients. However, synthesis of antibody was impaired in recipient mice treated with PHA intraperitoneally prior to receiving the antigen-containing cells by the same route. Inhibition of antibody production was not observed when recipients were treated with PHA absorbed with sheep red cells or when transfer of the antigen-containing peritoneal cells were carried out by the intravenous route. The amount of cell-associated radioactivity retained in the peritoneal cavities of PHA-treated mice 2 h after an intraperitoneal injection of ^{32}P-labeled macrophages was twofold greater than that in the saline control mice. The mechanism of action of PHA on humoral antibody production is discussed. (auth)

36715 IMMUNOLOGICAL MEMORY IN MICE. II. CELL INTERACTIONS IN THE SECONDARY IMMUNE RESPONSE STUDIED BY MEANS OF IMMUNOGLOBULIN ALLOTYPE MARKERS. Jacobson, E. B.; L'Age-Stehr, Johanna; Herzenberg, Leonard A. (Stanford Univ., Calif.). J. Exp. Med.; 131: 1109-20(1 Jun 1970).

Congenic mice, differing genetically only at the loci coding for immunoglobulin H chain (or Fc) structures, have been used to study cell interactions in the 7S (γG_{2a}) antibody response to sheep erythrocytes (SRBC), as detected by the Jerne plaque-forming cell (PFC) method. The interaction between thymus and bone marrow cells was studied in adult thymectomized irradiated recipients, protected with syngeneic bone marrow and injected with thymus cells from the partner congenic strain. All of the γG_{2a} PFC detected in the spleens of these mice were of bone marrow allotype. Adoptive secondary immune responses were then studied to determine whether a similar interaction between memory cells and bone marrow derived cells could be detected. Primed spleen cells from the partner congenic strain, or a subpopulation of these cells obtained by BSA density gradient fractionation, were injected into irradiated recipients alone, or together with syngeneic non-immune spleen or bone marrow cells. All γG_{2a} PFC detected in these experiments were of primed cell allotype. There was no evidence that antibody forming cell precursors in normal spleen or bone marrow participate in the adoptive secondary immune response detected 7 days after transfer of primed spleen cells. This was true regardless of whether the bone marrow cells were injected at the time of transfer, or were injected 1 to 2 wk earlier and allowed to become established in the spleens of recipient mice. Although no specific cell interaction was seen, bone marrow (and, to a lesser degree, normal spleen) cells were found to have a nonspecific enhancing effect on the adoptive secondary response when they were injected together with the primed spleen cells. This enhancement was not evident if the bone marrow cells were injected 1 or 2 wk prior to primed cell transfer. (auth)

36716 IMMUNOLOGICAL MEMORY IN MICE. I. PHYSICAL SEPARATION AND PARTIAL CHARACTERIZATION OF MEMORY CELLS FOR DIFFERENT IMMUNOGLOBULIN CLASSES FROM EACH OTHER AND FROM ANTIBODY-PRODUCING CELLS. L'Age-Stehr, Johanna; Herzenberg, Leonard A. (Stanford Univ., Calif.). J. Exp. Med.; 131: 1093-1108(1 Jun 1970).

Plaque forming cells (PFC) of different immunoglobulin classes producing antibodies against sheep erythrocytes were separated according to their buoyant densities by means of equilibrium centrifugation in a stepwise BSA gradient. In the period of 7 to 10 days after immunization γM PFC are markedly enriched in fractions of low density and relatively depleted in fractions of high density. The distribution of total γG PFC shows less enrichment in the lower density fractions and less depletion in the higher density fractions. The density profile for γG_{2a} PFC is even flatter, with a significant difference (depletion) relative to the unseparated spleen cells only in the highest density fraction. The density gradient distributions of cells able to transfer an adoptive immune response of the various immunoglobulin classes are markedly different from the PFC distribution. Cells obtained 7–10 days after immunization able to transfer an IgM response are present in the same proportions across the density gradient, whereas memory cells for γG_{2a} obtained at this time are markedly enriched in fractions of low density and virtually depleted from high density fractions. With increasing time after primary immunization, the γG_{2a} memory cells increase progressively in density and by 6 weeks the higher and lower density fractions have the same proportions of γG_{2a} memory cells. The total γG (mainly γG_1) memory cells by 7–10 days show slight enrichment in low density fractions and no depletion in high density fractions. The conclusions were reached that memory for γG_1 develops earlier than memory for γG_{2a} and that memory for anti-SRBC antibodies of different classes is carried in separate cells. When gradient fractions enriched for PFC and memory cells for all classes were completely depleted of PFC using glass bead columns, the ability of this fraction to transfer memory for all classes was not diminished. This shows that memory cells are not identical with cells secreting antibodies. (auth)

36717 IMMUNOLOGY OF INTERFERONS. II. HETEROSPECIFIC ACTIVITIES OF HUMAN INTERFERONS AND THEIR NEUTRALIZATION BY ANTIBODY. Levy-Koenig, R. E.; Golgher, R. R.; Paucker, K. (Univ. of Pennsylvania, Philadelphia, Statens Seruminstitut, Copenhagen). J. Immunol.; 104: 791-7 (Apr 1970).

Human interferons prepared by uv-irradiated Newcastle disease virus (NDV_{uv}) in six different cell types protected cultures of primary rabbit kidney cells at least as well as human foreskin fibroblasts against challenge with vesicular stomatitis virus. In addition, interferon obtained from human peripheral leukocytes protected L cells in low dilution. At adequate dose levels, all human interferons tested primed NDV_{uv}-induced interferon production in L cells. The heterospecific antiviral resistance promoted by human interferons in rabbit cells is not enhanced by treatment of the cultures with various polyionic compounds. The heterospecific protecting and priming effects of human interferons are neutralized by antibodies against rabbit and mouse cell interferons. The findings indicate that common antigens are shared by these three interferons, which may explain the unorthodox behavior of human interferons in heterologous systems. (auth)

36718 IMMUNOLOGY OF INTERFERONS. I. IMMUNE RESPONSE TO PROTECTIVE AND NONPROTECTIVE INTERFERONS. Levy-Koenig, R. E.; Mundy, M. J.; Paucker, K. (Univ. of Pennsylvania, Philadelphia, Statens Seruminstitut, Copenhagen). J. Immunol.; 104: 785-90(Apr 1970).

Rabbits immunized with protective interferons prepared in allogeneic RK 13 and SIRC cells failed to develop neutralizing anti-

bodies against either, although parallel groups of animals responded well to repeated injections of xenogeneic interferon prepared in L cells, which is non-protective for the rabbit host. All interferons which were xenogeneic and non-protective for guinea pigs elicited antibodies in that species. Significant levels of neutralizing antibodies appeared also in rabbits following immunization with two protective interferons derived from xenogeneic (human) cells. Immunologic analysis of human interferons elicited in four different types of cells revealed that minor antigenic variations may be detectable by means of antibody neutralization assays. (auth)

36719 TRANSFER OF SKIN HOMOGRAFT IMMUNITY WITH A PLASMA FACTOR. Dupuy, J. M.; Perey, D. Y. E.; Good, R. A. (Variety Club Heart Hospital, Minneapolis). J. Immunol.; 104: 1523-9(Jun 1970).

Passive transfer of skin homograft immunity was achieved in mice by injection of a small volume of plasma from grafted, x-irradiated, syngeneic donors. After injection of plasma, the mice received a skin graft from the same strain as those placed on the plasma donors. Recipients of plasma from irradiated, sensitized donors showed a marked acceleration of rejection as compared to controls. Neither plasma from grafted, non-irradiated mice, nor plasma from irradiated, non-grafted donors could transfer sensitivity to normal recipients. The plasma factor has been shown to be specific. Passive transfer of sensitivity could also be achieved with normal isologous spleen cells which had been incubated in vitro with plasma from grafted, x-irradiated donors. The nature of the factor responsible for transfer of this immunity remains to be determined. (auth)

36720 TRANSFER WITH A PLASMA FRACTION OF DELAYED HYPERSENSITIVITY TO PPD IN GUINEA PIGS. Dupuy, J. M.; Kalpaktsoglou, P.; Good, R. A. (Univ. of Minnesota, Minneapolis). J. Immunol.; 104: 1384-7(Jun 1970).

Passive transfer of delayed hypersensitivity to purified protein derivative (PPD) was achieved in normal guinea pigs with a fast migrating electrophoretic plasma fraction. Plasma from Mycobacterium tuberculosis immunized, x-irradiated donors was subjected to electrophoresis on agar blocks. Fractions were injected into different groups of guinea pigs, which were skin tested with 10 μg of PPD six days after the last injection. In separate experiments, all guinea pigs injected with fraction I or II (cathodal migration) and with fraction III (nonmigrating) were found to be negative. The transfer of biologic activity was always obtained with the anode-migrating fractions V and VI. These data permit the conclusion that conventional antibodies of beta and gamma mobility do not participate in the transfer. They also indicate that the transfer, in this model, is obtained with a fast migrating factor(s) (auth)

36721 EFFECTS OF IRRADIATION ON INITIAL AND ANAMNESTIC HEMOLYSIN RESPONSES IN RABBITS: ANTIGEN INJECTION BEFORE X RAYS. Taliaferro, William H.; Taliaferro, Lucy Graves (Argonne National Lab., Ill.). J. Immunol.; 104: 1364-76(Jun 1970).

Alterations in the rise and fall of the initial and anamnestic hemolysin responses were studied by immunizing groups of rabbits intravenously with $10^{8.3}$ fresh sheep red blood cells/kg before total-body x irradiation. Control groups for the two responses consisted of immunized unirradiated rabbits. Irradiation with a small (25 to 100 R) or large (500 to 700 R) dose was carried out at five stages in both responses, i.e., during induction, during the latent period, before and just after peak titer and during the so-called steady state. Over-all effects of irradiation were evidenced by stimulation (high peak titers, attained within normal times and rates) and delayed enhancement (high peak titers and/or prolonged production, attained after a retarded time and at decreased rates). Stimulation occurred maximally when a small dose of x rays was given during induction or during the latent period of the initial response, to a much less extent during similar stages of the anamnestic response and to a minor extent during the hemolysin rise and decline of either response. Delayed enhancement occurred maximally when a large dose of x rays was given during induction, the latent period or the acute rise of the initial response and to a less extent during similar stages of the anamnestic response. Delayed enhancement was only faintly evident in both responses when a large dose of x rays was given after peak titer in that more rapid declines of hemolysin were only occasionally interrupted by slight rises in hemolysin. These results on immunization before irradiation, in agreement with a study on immunization after irradiation, suggest that the immunologically competent initial cells, as compared to the memory cells, may be more easily stimulated and, although more or less equally injured, may recover more rapidly and may overcompensate for the injury for a longer time. (auth)

36722 EFFECT OF X-IRRADIATION ON DELAYED HYPERSENSITIVITY AND CIRCULATING ANTIBODY IN THE RAT. Bowser, Robert T.; Spence, Denise B.; Exum, Eurmal D. (Armed Forces Radiobiology Research Inst., Bethesda, Md.). J. Immunol.; 104: 1497-1501(Jun 1970).

Rats exposed to x radiation 24 hr before antigen administration exhibited detectable skin reactions to tuberculin two days later than nonirradiated sensitized controls. Reaction sizes illustrate that the irradiated rat experienced a decreased sensitivity to tuberculin which persisted through day 14. The radiation dose (475 rads) responsible for the observed depression of the delayed skin reactions produced a greater depression of the circulating antibody response. The results obtained suggest that the cellular and humoral immune responses in the rat are radiosensitive (auth)

36723 CELLS INVOLVED IN THE IMMUNE RESPONSE. XIV. THE IMMUNOLOGIC RESPONSE OF IRRADIATED RABBITS GIVEN ALLOGENEIC BONE MARROW CELLS INCUBATED WITH ANTIGEN AND/OR SUBJECTED TO IRRADIATION IN VITRO. Abdou, Nabih I.; Richter, Maxwell (Royal Victoria Hospital, Montreal). J. Immunol.; 104: 1009-15(Apr 1970).

Normal bone marrow antigen-reactive cells could be stimulated to commence the sequence of intracellular reactions characteristic of the afferent limb of the immune response by incubation with antigen in vitro in cell culture. Injection of these in vitro-stimulated bone marrow cells, along with antigen, into irradiated immunoincompetent recipients resulted in a reconstitution of the host's immune competence that was characterized by plaque-forming capacity in the spleen cells 7 days later. Recipients of cells irradiated following in vitro incubation with the antigen gave normal immune responses, whereas irradiation of the cells before in vitro incubation with the antigen completely suppressed the capacity of these cells to transfer immunocompetence. Bone marrow cells irradiated in vitro could exclude the trypan blue dye but failed to undergo blastogenesis and mitosis when cultured in the presence of phytohemagglutinin. Data in support of the clonal selection theory, with respect to the antigen reactive cells (ARC) present in the normal rabbit bone marrow, were also presented. Precommitment of the ARC to one antigen could not be subverted even if the cells were incubated for 24 hr in vitro in the presence of a second non-cross-reacting antigen in high concentration. Therefore, the ARC is unipotential with respect to antigenic specificity. (auth)

36724 MECHANISM OF EOSINOPHILIA. II. ROLE OF THE LYMPHOCYTE. Basten, Antony; Beeson, Paul B. (Oxford Univ.). J. Exp. Med.; 131: 1288-1305(1 Jun 1970).

A possible role for the lymphocyte in the mechanism of eosinopoiesis was examined. Procedures known to deplete or inactivate the pool of recirculating lymphocytes such as neonatal thymectomy, administration of antilymphocyte serum, and prolonged thoracic duct drainage, either singly or in combination, resulted in a highly significant reduction in the eosinophil response to trichinosis. Irradiated animals exposed to parasitic challenge did not develop eosinophilia unless reconstituted with lymphocytes as well as bone marrow cells. When memory cells were used instead of normal lymphocytes, a secondary type of eosinophil response was observed. Transfer of a primary eosinophilia was achieved adoptively with a population of living large lymphocytes from thoracic duct lymph and peripheral blood, but not with blood plasma or cell-free lymph. The potency of the active lymphocytes was not impaired by enclosing them in cell-tight diffusion chambers, indicating that they exerted an effect on bone marrow by agency of a diffusible factor. The demonstration of a role for lymphocytes in induction of the eosinophil response to this kind of stimulus supports the conclusion that eosinophilia belongs in the category of immunologic phenomena. (auth)

36725 INDUCTION OF IMMUNOLOGIC TOLERANCE IN OLDER NEW ZEALAND MICE REPOPULATED WITH YOUNG SPLEEN, BONE MARROW, OR THYMUS. Staples, Parker J.; Steinberg, Alfred D.; Talal, Norman (National Institutes of Health, Bethesda, Md.). J. Exp. Med.; 131: 1223-38(1 Jun 1970).

Newborn, 7 to 9 day, and 16 to 18 day old NZB and B/W mice were, unlike older New Zealand mice, rendered tolerant to single doses of 8 to 10 mg of soluble bovine γ globulin. After challenge, this tolerance was of short duration and escape occurred rapidly. Age-matched and similarly treated C3H, Balb/c and C57Bl mice did not escape from tolerance. Partial tolerance could be maintained by repeated injections of BGG. Biofiltration ruled out hyperphagocytosis as an explanation for this resistance to tolerance. Tolerance could be induced in older B/W mice if they were thymectomized, irradiated, and repopulated with young (12 to 15 day), but not old (2 to 3 month), spleen or bone marrow cells. Old bone marrow cells gave a nontolerant response even when combined

with young thymic grafts. Young bone marrow gave a tolerant response which was followed by the expected rapid escape only if a young thymus graft was also present. Escape was retarded if old thymus, or old irradiated thymus, was combined with young bone marrow. These results are best explained by abnormalities of both lymphoid precursors and thymic regulation. (auth)

Ecology

Refer also to abstracts 36543, 36684, and 36848.

36726 (BNWL-1377) RADIOECOLOGICAL STUDIES ON THE COLUMBIA RIVER. PART I. Watson, D. G.; Cushing, C. E.; Coutant, C. C.; Templeton, W. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). May 1970. 46p. Dep. CFSTI.

A study of radionuclide concentration levels in Columbia River biota was undertaken between Feb. 1966 and Sept. 1967 to define the interspecies and seasonal variations in the concentration of several of the more biologically important radionuclides, and update the findings of some of the earlier investigations. Concentrations of radionuclides in the Columbia River water are generally inversely proportional to flow levels, with highest values in winter and lowest in summer. This is related to dilution by seasonal runoff. Concentrations of most radionuclides in the biota followed a pattern of high levels in winter followed by low concentrations in summer. There were often indications of an increase in concentration just after levels started to decline in spring. This may be attributed to improved light and temperature regimes which favored metabolic uptake; this increase, however, was soon overwhelmed by the dilution of radionuclides by the spring runoff. A remarkable similarity in total β concentration was observed between the present data and that collected prior to 1956. In view of the environmental and technological changes which have occurred, this was quite unexpected. No consistent time related trends were apparent in the γ activity measurements between the present data and that collected prior to 1956. The shutdown of all reactors for several weeks during this study produced marked changes in the radionuclide concentrations in the biota. Levels of most nuclides dropped several orders of magnitude and many were undetectable. Measurable amounts of certain isotopes were present from radioactivity recycled from the sediments or small amounts coming from the reactor effluents. After the reactors resumed operation, levels increased rapidly to pre-shutdown levels or higher. Concentration factors were highest for the biologically important radionuclides ^{32}P and ^{65}Zn and were highest in the primary producers, net plankton and periphyton, and decreased in higher trophic levels. Data are presented on the content of ^{32}P, ^{65}Zn, ^{51}Cr, ^{54}N, ^{59}Fe, ^{95}Zr, ^{95}Nb, and ^{46}Sc in Columbia River water, algae, plankton, caddisfly larvae, limpets, and selected fish. (C.H.)

36727 (CEA-N-1299) THE ^{90}Sr CONTENT OF HUMAN BONES COLLECTED IN 1968. Jeanmaire, Lucien; Patti, Francois (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Apr 1970. 13p. (In French). Dep. CFSTI (U. S. Sales Only).

This report follows the previous reports CEA-R-3381 and CEA-R-3681. The ^{90}Sr contents of human bones collected in 1968 are presented for the Paris area. The results obtained in every range of age are tabulated. The main trend of the evolution shows lower contamination levels for people under 20 years of age and stable levels above this age. (France)

36728 (EUR-4411) LEVEL OF RADIOACTIVE CONTAMINATION IN THE ENVIRONMENT AND IN THE FOOD CHAIN. Annual Report, 1968. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). 3 Sep 1969. 62p. (In French). Dep. CFSTI (U. S. Sales Only). FF 9,45.

In human biology, interesting results were obtained in the field of the metabolism of ^{125}I and ^{131}I in children. The study of the metabolism of strontium and the development of physiological factors according to age was also continued. Research into the transfer of environmental pollution to foodstuffs was extended, a distinction being made between problems linked with the atmosphere, soil and water depending on their origin. Work has been carried out on the estimation of the contamination level of ^{137}Cs, ^{131}I, and ^{90}Sr from the results of the synthesis studies completed so far. Finally, this report sets out the main points of studies relating to the distribution circuits of cereals and their by-products in the countries of the European Community. (Euratom)

36729 (JUL-603-ST, pp 7-84) RADIOACTIVITY IN THE ENVIRONMENT OF THE NUCLEAR RESEARCH CENTER JUELICH DURING THE YEAR 1968. Vogt, K. J.; Jacobs, H.; Polster, G. (Kernforschungsanlage, Juelich (West Germany). Zentralabteilung Strahlenschutz). (In German).

The environment is divided into an inner circle with a radius of one km around the nuclear center that is occupied by professional personnel; and the outer circle of a three km radius that contains several settlements. Radioactivity is constantly measured in air, water, soil, vegetables, and milk. Data are fed into a radiation protection center that, in the case of incidents, triggers a warning system for the endangered population. The various techniques employed for gathering samples, preparation, and counting are discussed. It is concluded that the environmental radioactivity is essentially determined by remnants of former nuclear weapons tests. Fallout from French and Chinese test explosions contributed to the activity. The nuclear center itself did not affect the radionuclide content of its environment. Data are documented by 31 tables and 23 figures. (H.B.G.)

36730 (JUL-603-ST, pp 85-92) OFFICE FOR COORDINATION OF RADIOACTIVE EMISSIONS. Vogt, K. J. (Kernforschungsanlage, Juelich (West Germany). Zentralabteilung Strahlenschutz). (In German).

The coordination office is charged with monitoring all radioactive emissions from the Juelich nuclear research center. To assess possible contamination of the environment, three groups of nuclides are distinguished. The first one does not enter the body during inhalation and comprises mainly γ-emitters, with ^{41}Ar as representative. The second group also does not enter the body by inhalation but predominantly releases β particles, with ^{85}Kr as representative. The third group is absorbed by inhalation and ^{131}I is chosen as representative. For each of the three groups mathematical formulas are given that allow calculation of permissible concentrations. During 1968, contamination of the environment by radioactivity released in the air was several orders of magnitude below permissible levels. Water contamination also was below standards applying to general populations. Findings are documented by five tables. (H.B.G.)

36731 (NYO-3970-44) RADIATION HAZARDS IN ENVIRONMENTAL MEDICINE. Fabrikant, Jacob I. (Johns Hopkins Univ., Baltimore, Md. Dept. of Radiological Sciences). 5 Aug 1969. Contract AT(30-1)-3970. 11p. Dep. CFSTI.

Natural radiations and radioactivity have always been unique physical properties of the world and an integral part of the natural environment of all living things. From the beginning of time, a fine balance has been reached so that whatever mutagenic effects occurred, radiation has always played an important role in the natural selection and survival of all biological species. However, in the very recent past, less than 75 years, this balance has been perturbed by the introduction of man-made sources of radiation, through the medical use of x rays and isotopes and from the developments of atomic energy in industry and for nuclear weapons. Medical x rays, both diagnostic and therapeutic, represent by far the largest man-made source of radiation exposure to the general population at the present time. In 1964 in the United States, 506 million medical radiological x ray exposures were given to 108 million persons, or to ~60% of the population of this country. By 1969, an estimate of approximately two-thirds of the population would be conservative. Of particular concern is the average gonadal dose received by the population as a whole since this will determine the rate at which genetic mutations are introduced into the population pool. From this standpoint it is the total population dose that is important. From a recent survey of x ray exposures during radiological examinations performed at The Johns Hopkins Hospital, it was estimated that the average annual gonadal dose from diagnostic x rays to the entire population of the United States for the middle-aged groups was ~60 mrem per year, or about half the natural background exposure. This has been considered as a conservative underestimate, and could be off by a factor or two. At present, exposure from therapeutic radiation and radioactive isotopes in medical practice affects only a relatively small fraction of the population. Their importance, however, is steadily increasing. In the future, medical radiation exposure to the world population as a whole will probably increase significantly with the development of new procedures and the increased availability of advanced medical care throughout the world. Radioactive isotopes released from nuclear weapons explosions or atomic energy installations may become a significant factor in the future. These isotopes are important not only as internal radiation hazards from contaminated food, water, and air, but also in their effects on the physical and biological ecosystems in dynamic equilibrium. It is evident, therefore, that the problems of research, development, and protection in the evaluation of these risks from radiation are

complex and quite different from those for conventional external sources. (C.H.)

Genetics and Cytogenetics

Refer also to abstracts 36698, 36699, 36704, and 36848.

36732 (COO-1609-34) GENETIC STUDIES ON SOMATIC CELLS OF THE HIGHER PLANT, ARABIDOPSIS. Final Progress Report, April 1, 1966-April 30, 1970. Redei, G. P. (Missouri Univ., Columbia). Contract AT(11-1)-1609. 12p. Dep. CFSTI.

Induction of somatic sector formation in Arabidopsis following exposure to x radiation or treatment with ethyl methanesulfonate (EMS) was studied. Ethyl methanesulfonate induced more mutations in the germline than x radiation but was less effective than radiation for the induction of locus specific alterations in the soma. Thin layer chromatography was used to identify genetic changes at a certain locus in a chlorophyll-b deficient mutation. Results of studies of somatic recombination in several linkage groups, the genetic control of recombination, biochemical mechanisms of heterosis, and the induction of temperature sensitive mutants are reported. (C.H.)

36733 (NYO-2803-19) PROGRESS REPORT [ON MECHANISMS OF THE LETHAL AND MUTAGENIC ACTION OF IONIZING RADIATION IN ESCHERICHIA COLI AND YEAST], JANUARY 1, 1961-MARCH 15, 1968. (Institut Pasteur, Paris (France)). Contract AT(30-1)-2803. 23p. Dep. CFSTI.

The effects of various doses of γ, x, and uv radiations on Escherichia coli K12 were studied by genotype analysis and studies of recombination and transfer of genetic markers during mating. Some problems not directly related to radiation have been explored during the development of this work. Results are included from a study of a mutation of Saccharomyces cerevisiae resistant to x rays induced by ^{32}P disintegrations. (auth)

36734 STUDIES ON VARIETAL DIFFERENCES IN RADIOSENSITIVITY IN RICE. VI. DIALLEL ANALYSIS OF RADIOSENSITIVITY WITH RESPECT TO REDUCTION IN ROOT LENGTH. Ukai, Yasuo (Tokyo Univ.). Jap. J. Genet.; 45: 35-44(Mar 1970).

The results of diallel analysis of radiosensitivity in six rice varieties were presented. The criterion of radiosensitivity used was reduction in root length following an exposure of the seeds to gamma-rays. It was found that: The temperature under which the seeds ripened had a strong influence not only on mean radiosensitivity but also on the genetical behavior of radiosensitivity in the subsequent generation. After a 20°C treatment, radiosensitivity was determined by a genetic system of additive effect and incomplete dominance. No evidence for nonallelic interaction was obtained. After a 30°C treatment, however, a non-allelic interaction was observed, which was due to two particular parental lines; their removal recovered additivity between loci of the remaining parents. After the 20°C treatment, dominance was in the direction of both increasing and decreasing sensitivity, while dominance after 30°C treatment was in the direction of increasing. The proportion of dominant alleles to all parental alleles also differed according to the temperature treatment. No correlation was found between the radiosensitivity shown by log 100 K and the root length of the control. (auth)

36735 STUDIES ON INDUCED MUTATIONS IN PEAS. XXV. GENETICALLY CONDITIONED DIFFERENCES IN RADIATION SENSITIVITY. 3. Blixt, S. Agri Hort. Genet.; 27: Nos. 3 and 4, 78-100(1969).

It had been found that genetic factors influenced the radiosensitivity of peas. These findings were reinvestigated using larger numbers of γ-irradiated seeds. Sixty-two different genotypes were tested for γ-radiosensitivity using germination, growth, and leaf-spotting as criteria of radiation effects. In general the previous results were confirmed and extended. Individual genes as well as the number of recessive alleles carried by a certain line affected radiosensitivity. Earliness, as measured by the time from sowing to flowering and to maturity, also affected sensitivity. (M.M.B.)

36736 HUMAN CYTOGENETICS. Programme and Abstracts of Papers Presented at the 2nd Human Cytogenetics Conference, Randwick, Australia, 11th February 1970. Lucas Heights; New South Wales; Australian Atomic Energy Commission Research Establishment (1970). 9p. (CONF-700205).

Abstracts only are presented. Of the ten abstracts, four deal with accidental radiation or autoradiographic effects on chromosomes. (auth) (Australia)

36737 X-RAY INDUCED DAMAGES TO THE MEIOTIC CHROMOSOMES OF GRASSHOPPERS AND THEIR REPAIR. Mazumder, S. C.; Manna, G. K. (Univ. of Kalyani, West Bengal, India). Sci. Cult. (Calcutta); 35: 510-14(Sep 1969).

Adult male grasshoppers (Oxya velox and Phlaeoba antennata) were x-irradiated with a dose of 160 R and the testes were fixed at intervals of 5 min to 24 days following irradiation. One group of Phlaeoba antennata were given abdominal injections of ethyl alcohol just before irradiation as a protective measure. Aberrations in the form of gaps and breaks of the X chromosome in the late spermatocyte prophase cells were counted and results are tabulated. The frequency of aberrations in the alcohol-treated grasshoppers was considerably less than that of untreated insects. Repair mechanisms by joining of broken ends of chromosomes, chromosome interchanges, and chemical effects are discussed. (H.L.W.)

36738 CHROMOSOMAL TRANSLOCATION HETEROZYGOTES IN THE HOUSE FLY. EGG HATCH, SEX RATIOS, AND TRANSMISSION TO PROGENY OF 193 TRANSLOCATIONS. Wagoner, Dale E.; Nickel, Curtis A.; Johnson, Odell A. (Dept. of Agriculture, Fargo, N. D.). J. Hered.; 60: 301-4(1969).

The use of chromosomal translocations for insect control is theoretically very promising. Thus, genetic and cytogenetic examinations were made of 193 stocks containing heterozygous chromosomal translocations induced by x ray in the housefly by crossing males bearing the translocations to appropriately marked females. The effects of irradiation on the fertility of treated flies, the frequencies of induced translocations and the reduction in fertility, the sex ratios of progeny, and the transmission of the translocations to progeny of heterozygous translocation bearing males were measured. Both autosome-autosome and Y-autosome translocations reduced fertility and transmitted a sufficient proportion of translocated chromosomes to the progeny to warrant making cage tests to study the population reducing potential of these gross chromosomal rearrangements. (auth)

36739 MUTATION BREEDING OF STREPTOCARPUS. Broertjes, C. (Inst. of Atomic Sciences in Agriculture, Wageningen, Netherlands). Euphytica; 18: 333-9(1969).

Leaves of Streptocarpus Constant Nymph have been irradiated with x rays and fast neutrons. Considering the production of plantlets on the rooted leaf-halves as well as the frequency of mutants among them, the optimal dose for x rays was found to be 3 krad. Like Saintpaulia ionantha, Streptocarpus produces solid mutants after irradiation, a fact which indicates that each plantlet, developing from an adventitious bud, originates from only one cell. Moreover, a high mutation frequency has been observed as well as a wide variability among the 857 mutants obtained. Application of a heavy x ray dose (4 to 5 krad) a few days after colchicine treatment resulted in a frequency of tetraploids which was twice the one obtained after colchicine treatment alone. A number of mutants and (auto)tetraploids have been propagated and tested for their commercial value. So far, 5 mutants have been commercialized, viz., Purple Nymph, Mini Nymph, Blue Nymph, Netta Nymph and Cobalt Nymph. (auth)

36740 INFLUENCE OF 5-AZACYTIDINE ON REVERSION RATE AND UV-SENSITIVITY OF ESCHERICHIA COLI K_{12} STRAINS WITH DIFFERENT UVR-GENES. Z. Naturforsch.; 25b: 537-42(May 1970). (In German).

Three μg of 5-azacytidine (AC)/ml causes an inhibition of cell division of Escherichia coli K12 strains. This concentration is not mutagenic, because the reversion frequencies of the markers thr^-, his^- and arg^- are not changed by AC treatment. However, the reversion frequencies of thr^- and arg^- increased 1 to orders of magnitude after UV irradiation, simultaneous treatment with AC and UV decreased these enlarged reversion rates at 1 exponent. The marker his^- used in this experiment is not reverted by UV. The UV-sensitivity of bacterial strains with different uvr-genes was studied. The results are discussed from the viewpoint that the influence of AC caused an inhibition of protein synthesis whereby phenotypic expression of UV induced DNA damage is delayed and the time for repair of DNA is enlarged. (auth)

36741 INFLUENCE OF OXYGEN LET ON RADIATION-INDUCED MUTATION WHEAT. Blixt, S. (Weibullsholm Plant Breeding Inst., Landskrona, Sweden); Dumanovic, J.; Ehrenberg, L.; Loefroth, G. Agri Hort. Genet.; 26: 66-77(1968).

Kernals of the Spring wheat (2n = 42), variety Rival, were irradiated anaerobically and aerobically with γ rays and aerobically with fission neutrons. At comparable lethal doses ($RBE_{n/\gamma-air} = 40$; $RBE_{\gamma-N_2/\gamma-air} = 1.50$) the following efficiencies in inducing genetic effects were determined: (a) Neutrons induced X_1 speltoid chimeras in an almost linear dose-dependence, whereas both γ ray series exhibit the same, exponential, dose-dependence with high proportions of chimeric plants reached around DL_{75}. (b) Neutrons induced speltoid and other morphological mutants observed in X_2,

in a linear dose-response, whereas aerobic γ irradiation gave very low mutation rates which are evidently ascribable to a marked elimination of mutation cases. This elimination was less pronounced for anaerobic γ irradiation, which is thus mutagenically more efficient than aerobic γ irradiation. At low doses the efficiency is about the same as that with neutrons. These results are in general agreement with MacKey's earlier data, and with conclusions from somatic radiation effects that lesions induced by neutrons and anaerobic γ radiation are mainly ascribable to genetic damage, in contrast to the effects of aerobic γ radiation. (auth) (Sweden)

36742 GENETIC STUDIES OF THE BLUE-GREEN ALGA, ANACYSTIS NIDULANS. Asato, Yukio. Honolulu, Hawaii; Univ. of Hawaii (1969). 111p.

Thesis.

Inactivation studies on Anacystis nidulans were performed using uv irradiation and nitrosoguanidine. Ultraviolet irradiation had no effect when the treated culture was first incubated in the light. When the uv irradiated culture was first incubated in the dark for 9 hours, an exponential survival curve was obtained with slope $k = 0.23 \log S/S_0$ ergs · cm. The photoreactivable sector was calculated to be one. A slight shoulder in the survival curve was observed. Extrapolation of the asymptote to the y-axis indicated a target number of two. The response to nitrosoguanidine was found to be concentration dependent. Mutation experiments were conducted mainly with nitrosoguanidine. A variety of mutant phenotypes was found upon induction with nitrosoguanidine treatment. These were minute colony formers (mcf), filamentous forms, (snakes or sna), yellow (yel) and blue (blu), polymixin B (pmb^r) and kanamycin (kan^r) resistance. The frequencies of occurrence were: 3.7×10^{-3} (mcf), 1.0×10^{-3} (sna), 1.8×10^{-3} (yel), 2.98×10^{-3} (blu) and 4.8×10^{-4} (pmb^r). Auxotrophic mutants were not recovered even after screening approximately 8.0×10^4 surviving colonies with the replica plate method. Cell synchrony was induced by a light-dark regimen. The rates of macromolecular synthesis of the synchronous culture were determined. Protein, RNA, and phospholipid fractions increased exponentially. DNA synthesis was periodic. An abrupt increase in the rate of DNA synthesis was seen at 3 hours prior to the cell division periods. The period of DNA synthesis was 6 to 7 hours. The times of abrupt increases in the rate of DNA synthesis were inferred to be the times of initiation of genome at a fixed point of replication. A genetic map was constructed by taking advantage of cyclic DNA synthesis of synchronously dividing cells. Sequential mutagenesis during the period of DNA synthesis yielded unique temporal patterns for specific marker frequencies. The patterns showed an initial plateau, an abrupt increase, then, a second plateau. Slopes of the abrupt increases were calculated. The times of the abrupt increases were then designated as the times of the replication of the cistrons and, correspondingly, the loci of the markers in time units. The loci of six markers were presented as the genetic map of Anacystis nidulans. These were pmb^r, blu, yel, sna, mcf, and kan^r in that temporal order. (Diss. Abstr.)

36743 SOME RADIATION INDUCED CHANGES AT Q LOCUS IN BREAD WHEAT (TRITICUM AESTIVUM L.). Singh, M. P. (Indian Agricultural Research Inst., New Delhi). Caryologia; 22: 119-26(Apr-Jun 1969).

The relative role of radioinduced mutations influenced or associated with the "Q" locus was studied in three varieties of wheat. Dry seeds were irradiated with x rays, phosphorus-32, sulfur-35, γ rays, and fast neutrons. Mutations associated with the "Q" locus were classified as speltoid, compactoid, hypercompactoid, or Vovilovoid based on their phenotypic appearance. Mutants were screened in the M_2 and M_3 generations. The cytogenetic evidence for the origin of these mutants and their significance as an index of overall mutation frequency in different wheat varieties are discussed. The "Q" locus influenced or associated radioinduced mutations constituted a major portion of those observed and their predominance remained unchanged in the different varieties irrespective of dose or type of radiation. (M.M.B.)

Health Physics and Safety

Refer also to abstracts 36543 and 38602.

Radioactive Contamination and Decontamination

Refer also to abstracts 36688, 36697, 36712, 36726–36728, and 36757.

36744 (JUL-603-ST, pp 109-18) PERSONNEL MONITORING: MEASUREMENT OF INTERNAL RADIATION BURDEN. Rose, E.; Jacobs, H. (Kernforschungsanlage, Juelich (West Germany). Zentralabteilung Strahlenschutz). (In German).

Monitoring of personnel at KFA Juelich was performed with a whole-body counter and measurement of excretion. The whole-body counter still is in a preliminary stage of development. 448 routine determinations were performed and 144 cases involving suspicion of excess incorporation of radioisotopes. Only one case of relatively high contamination with 50 microcuries of ^{124}Sb was found. 580 measurements of excretions were performed. Suspicion of radioisotope uptake required 204 measurements of 85 individuals. Two cases of significant, but not dangerous, uranium excretion were observed. One individual showed high, but not excessive, tritium elimination. (H.B.G.)

36745 (JUL-603-ST, pp 143-50) MONITORING OF OPERATIONS: RADIATION PROTECTION WITHIN THE DIVISION FOR RESEARCH REACTORS. Jahn, H.; Laumen, K. J. (Kernforschungsanlage, Juelich (West Germany). Zentralabteilung Strahlenschutz). (In German).

230 personnel at KFA Juelich were monitored for external and internal radiation exposure. None of the personnel reached permissible doses. Routine monitoring was supplemented by whole-body counting and analysis of excretions. In the average per year, one or two cases of external contamination occurred per working day. Complete decontamination was achieved by washing and showering with soap. A few severe contamination cases were treated successfully with gasoline. Continuous monitoring of ^{41}Ar and tritium was performed. In a swimming pool reactor, the externally released radiation was decreased significantly by the induction of an inversion layer that was produced by heating of the superficial water section. Temperature measurements showed that the inversion layer of water vapor acted as an effective shield against external radiation. In addition, the release and detection of ^{41}Ar was studied both theoretically and experimentally. (H.B.G.)

36746 (JUL-603-ST, pp 151-2) MONITORING OF OPERATIONS: CHEMISTRY. Jacobs, H. (Kernforschungsanlage, Juelich (West Germany). Zentralabteilung Strahlenschutz). (In German).

Chemical procedures for monitoring uranium and tritium contamination of personnel at KFA Juelich are discussed. Blowing of the nose into tissue is a valuable tool. Although quantitative assessment of radioactive contamination is impossible, important leads to the type of radioisotope are easily obtained in the case of unknown contamination. Moreover, blowing of the nose frequently removes radioisotopes that would have otherwise entered the gastrointestinal tract. Preparations of standards for the measurement of α, β, and γ-emitters are briefly outlined. (H.B.G.)

36747 (JUL-603-ST, pp 157-74) DOSIMETRY FOR PERSONNEL AND LOCATION: HEALTH PHYSICS MEASURES FOR THE OPEN HANDLING OF RADIOACTIVE MATERIALS WITH RESPECT TO TOXIC AMOUNTS OF INCORPORATION, RISK OF INCORPORATION, AND PREVENTIVE MEASURES. Keller, M. (Kernforschungsanlage, Juelich (West Germany). Zentralabteilung Strahlenschutz). (In German).

By whole-body counting and elimination measurements, the radioisotope burden was determined in several hundred personnel of the KFA Juelich. Of the personnel who were routinely monitored, 1 to 7% showed higher than normal radioisotope levels. If suspicion of excess incorporation existed, however, 42 to 98% of the personnel actually showed an enhanced radioisotope burden. None of these cases was clinically significant. Protective measures for the handling of open radioisotopes are discussed and their practical application at the KFA are briefly outlined. The measures correspond with those generally applied in work with radioisotopes. (H.B.G.)

36748 (JUL-603-ST, pp 175-85) DOSIMETRY FOR PERSONNEL AND LOCATION: RESULTS OF WHOLE-BODY COUNTING AND EXCRETION MEASUREMENTS FOLLOWING ACUTE INCORPORATION OF ^{124}Sb. Rose, E.; Jacobs, H.; Meringdal, J. (Kernforschungsanlage, Juelich (West Germany). Zentralabteilung Strahlenschutz). (In German).

For unknown reasons, a cobalt sample was highly contaminated with antimony. Following activation in the reactor, the person handling the sample showed significant contamination. Whole-body counting identified the isotope as ^{124}Sb. Decontamination attempts in a shower were unsuccessful. Detergents and chelating agents, however, practically eliminated the external contamination. Within the first ten days 99% of the internal activity was excreted. Thereafter, the remaining activity decreased exponentially with a half life of approximately 30 days. The total amount of incor-

porated ^{124}Sb was estimated at 35 μCi. The main activity was found in nose, throat, and lungs, and in the gastrointestinal tract. The lung contamination persisted throughout the period of observation. Dose determinations showed 0.15 REM for the whole body, 2 REM for the head, and 5 REM for the gastrointestinal tract. Excretion measurements showed for gastrointestinal fract to kidneys 1000 to one. (H.B.G.)

36749 (JUL-603-ST, pp 223-6) ACTIVITY AND SHIELDING: STANDARD PROCEDURES FOR THE STUDY OF DECONTAMINATION OF SURFACES. Sauermann, P. F.; Graf, H.; Voelkel, E. (Kernforschungsanlage, Juelich (West Germany). Zentralabteilung Strahlenschutz). (In German).

Various samples of building materials, such as floor tiles, wall paints, and ceiling compounds were contaminated either with single radioisotopes or with a mixture of fission products. Subsequently, the samples were washed in water, treated with a commercial detergent (RBS), especially designed for laboratory equipment and, finally, rubbed with cellulose soaked with RBS. If the method did not lead to complete decontamination, 5% nitric was applied. The method appeared suitable to evaluate the decontamination possibility of surfaces. (H.B.G.)

36750 DISPOSAL OF LIQUID WASTES INTO COASTAL WATERS. Templeton, W. L. (Battelle Memorial Inst., Richland, Wash.). Chem. Eng. Progr.; 66: No. 2, 45-50(Feb 1970).

The disposal of liquid radioactive wastes into coastal waters at the Bradwell Station and Windscale site was evaluated. The assessment of risk to man from such discharges in UK is controlled by authorizations under acts of Parliament, the Ministry of Housing and Local Government, and the Ministry of Agriculture, Fisheries, and Food. The standards of the International Commission on Radiological Protection are given. The radioactive waste at Windscale, arising as a byproduct from the chemical processing of irradiated nuclear fuel occurs as large volumes of aqueous solutions with a low-level radioactivity concentration. Ruthenium-106 content in Porphyra umbilicalis as a function of distance from Windscale was determined. The edible seaweed is used for the manufacture of laverbread, and an estimation of radioactivity in the lower intestine of adults was made. The critical material that determines the maximum permissible rate of discharge for aqueous radioactive effluent at the Bradwell Station is oysters consumed by the population. Zinc-65 is the critical nuclide, but also concentrations of cobalt-60, cesium-137, and iron-55 in the oysters can be used to estimate the organ dose-rates experienced by the consumers.

36751 ON THE RELATIONS BETWEEN THE DECONTAMINATABILITY OF CHICKEN EGGS EXTERNALLY CONTAMINATED WITH RADIOACTIVE STRONTIUM AND RADIOACTIVE CESIUM, AND STORAGE FOLLOWING CONTAMINATION. Grunewald, Horst. Arch. Exp. Veterinaermed.; 23: 793-7(Sep 1969). (In German).

The length of storage following contamination with ^{90}Sr and ^{137}Cs affected the ease of removal of the ^{137}Cs but not that of the ^{90}Sr. The decontaminant used was a 2% solution of citric acid in water. Up to a period of 100 days following contamination, the ease of decontaminating the ^{90}Sr remained the same; however, the ^{137}Cs became more and more difficult to remove as time progressed. Even a few days made removal noticeably more difficult. (JPRS)

36752 SYNTHESIS OF CYCLOPENTANEDIAMINETETRAACETIC ACID, A NEW CHELATOR FOR THE INTERNAL DECONTAMINATION OF RADIOSTRONTIUM. Weber, O. A.; Paulic, Nevenka; Purec, Ljerka (Inst. for Medical Research, Zagreb). Arh. Hig. Rada Toksikol.; 19: 55-9(1968). (In French).

The organic, metal-chelating agents usually form less stable complexes with Sr than with Ca. An exception is cyclopentanediaminetetraacetic acid (1,2-CPDTA). The stability constants for various chelating agents are compared, showing 1,2-CPDTA to have the most favorable ratio for Sr and Ca. Thermodynamic aspects of the binding reaction and the effect of ionic radius are discussed with reference to the various agents. Synthesis of 1,2-CPDTA is described in detail. The preparation begins with synthesis of the ethyl ester of adipic acid, that is treated with Na metal. The resulting cyclic keto ester is treated with $NaNO_2$ in alkaline medium (Dickmann condensation) to form cyclopentanedionemonoxime, then the dioxime by treatment with hydroxylamine. The dioxime is reduced with Al + Ni and the product condensed with HCl to give 1,2-CPDTA. The pK values of this and other chelators are tabulated. (BBB)

Dosimetry and Monitoring

Refer also to abstracts 36420, 36553, 36559, 36595, 36626, 36795, 36838, 37368, and 38585.

36753 (JUL-603-ST, pp 101-8) PERSONNEL MONITORING: MEASUREMENT OF EXTERNAL RADIATION BURDEN. Rose, E. (Kernforschungsanlage, Juelich (West Germany). Zentralabteilung Strahlenschutz). (In German).

During 1968, 1,258 personnel were monitored in the KFA Juelich. The findings are tabulated. All radiation doses were well below the permissible level. Routinely, film dosimeters and ionization chambers were used. When hands were prone to radiation exposure, special ring dosimeters and wrist bands were employed. Due to their interference during work, replacement of these indicators by thermoluminescence dosimeters consisting of lithium fluoride in teflon was suggested. (H.B.G.)

36754 (JUL-603-ST, pp 128-38) MONITORING OF OPERATIONS: MONITORING OF DEPARTMENTS. Sauermann, P. F.; Broecking, D.; Schneider, K.; Meyer, H. (Kernforschungsanlage, Juelich (West Germany). Zentralabteilung Strahlenschutz). (In German).

Twenty departments of the KFA Juelich with 1,050 personnel were monitored. In most cases, no deviation from background radiation was found; in some departments, radiation levels were slightly above background; only in the fuel element laboratory definite radiation levels were observed. It was suggested that film dosimeter readings and the use of ionization chamber dosimeters be decreased in most departments because of both economy and lack of necessity. During 1968, 20 incidents with possible contamination occurred. In the majority of cases, contamination involved clothing and skin. None was of medical significance. Causes and prevention of such incidents are discussed. (H.B.G.)

36755 (JUL-603-ST, pp 187-9) DOSIMETRY FOR PERSONNEL AND LOCATION: EXPERIMENTAL STUDIES OF BETA DOSIMETRY WITH LITHIUM FLUORIDE TEFLON DOSIMETERS. Heinzelmann, M. (Kernforschungsanlage, Juelich (West Germany). Zentralabteilung Strahlenschutz). (In German).

In the handling of open radioisotope sources, frequently beta radiation to the hand is more critical than gamma radiation. Therefore, film dosimeters in the form of bands around fingers or wrist are unreliable and often misleading. Much more effective are lithium fluoride dosimeters embedded in thin layers of teflon. Some of the lithium fluoride dosimeters were exposed to experimental beta particles and the results presented in a table. (H.B.G.)

36756 USE OF THERMOLUMINESCENT DOSIMETERS TO STUDY THE EDGE EFFECT OF PHOTONS IN A BOUNDED MEDIUM. Clawser III, Samuel Matthew. Norman, Okla.; Univ. of Oklahoma (1969). 86p.

Thesis.

The dose distribution in a bounded absorber was investigated as a function of source location and of the perpendicular distance between the location of interest and a boundary, for three primary photon energies (123 keV, 383 keV, and 662 keV). In evaluating the experimental perturbation of the dose distribution in a bounded medium, Harshaw LiF-100 extruded rods were exposed to three monoenergetic point-isotropic gamma sources (Co-57, Sn-113, and Cs-137), in two independent experimental models. It was shown that there exists no detectable effect on the thermoluminescent readings when a constant source-to-detector geometry was varied with respect to the boundaries of the experimental phantom. The modification of the experimental dose distribution due to the effects of the boundaries was shown graphically as a function of perpendicular distance from the nearest boundary. In addition, the critical region where edge effects occurred was determined. The edge effect on one plane of the detector slab was found to be independent of whether or not the slab was 5cm from the top of the phantom or centrally located in the phantom. The methodology of thermoluminescent dosimetry and of internal dose calculations was also discussed. The experimental phantom, sources, and detectors were good approximations for point-isotropic, tissue-equivalent, homogeneous models. Variance analysis was maintained for all measurements, and expedited the determination of conclusions. The results of this dissertation can be used to compute the absorbed dose in clinical dosimetry with increased ease and accuracy. (Diss. Abstr.)

36757 DETERMINATION OF LOW-LEVEL ^{137}Cs ACTIVITIES IN MEAT BY MEASUREMENTS WITH THIN PLASTIC PHOSPHORS IN 4π-GEOMETRY. Marinov, V. (Veterinary Inst. of Contagious and Parasitic Diseases, Sofia); Dimchev, T.; Vrigazov, A.; Alexandrov, D. Kernenergie; 12: 397-400(Dec 1969).

Investigations were made on the ^{137}Cs content in pork, beef, calf, and mutton consumed in Sofia during 1967. Wet ashing was used in determining ^{137}Cs in the samples, and caesium silicotungstenate precipitation served as the basis of the radiochemical separation. In measuring the activity, a scintillation method was applied with

thin organic plastics in 4π-geometry, the two channels being connected in a diagram of anticoincidence with a stable background of 0.8 cpm. An equalization of the ^{137}Cs content has been established for the different types of meat. The average daily introduction of ^{137}Cs with the meat amounts to 13.5 pCi for 1967. (auth)

36758 MEASUREMENT UNCERTAINTY, CAUSED BY THE FINITE LENGTH OF THE DETECTOR. Mauderli, W.; Fitzgerald, L. T.; Lorenz, E.; Gross, C. E. (Univ. of Florida, Gainesville). Fortschr. Geb. Roentgenstr. Nuklearmed.; 112: 267-73(Feb 1970). (In German).

Mathematical models were prepared for various arrangements of radiation source and detector, using a point, linear and cylindrical detector. The relationship between average dose and dose at the center of the detector was determined numerically for linear and cylindrical detectors. Diagrams were prepared to show the relationships for various positions of the detector and for several typical arrangements of the radiation source and the detector. The following conclusion can be reached: in order to be certain that the error does not exceed 5%, measurements should be carried out with the detector not less than 1½ times the length of the detector from the radiation source. (F. St.)

36759 ADVANTAGES OF INCREASING TUBE VOLTAGE FROM 200 TO 300 kV IN CONVENTIONAL X-RAY THERAPY, AS DEMONSTRATED BY THE EXAMPLE OF PENDULUM IRRADIATION OF ESOPHAGUS CARCINOMAS. Rassow, Juergen; Knapp, Horst Werner (Ruhr Univ., Essen). Strahlentherapie; 139: 284-90(Mar 1970). (In German).

The advantages of 300 kV radiation over 200 kV are studied in the Alderson phantom. The example presented is the irradiation of the esophagus with pendular techniques with three different field widths. The main two advantages are an appreciable reaction of irradiation times, i.e., higher dose rates for the same penetration strength, and better dose distribution with lower doses to neighboring tissues because of more penetrating radiation, with HVT up to 4.35 mm Cu. (auth)

36760 RADIATION DOSES IN THE ALTITUDE OF SUPERSONIC TRANSPORT FLIGHTS. Allkofer, O. C.; Simon, M. (Christian-Albrechts Univ., Kiel). Atomproxis; 16: 186-90; 193-5(May-Jul 1970). (In German).

At the altitude of supersonic transport flights, the radiation doses caused by cosmic radiation will be about 500 times higher than that near sea level. In addition to the heavy primaries which have to be regarded separately, the galactic components yield a constant total dose. The contribution by the solar flares can be noted for the most part by a general increase of the total dose whereas for the rare extreme events, the crew has to be warned by forecasts before start or has to descend into deeper atmospheric layers during the flight. All components are estimated and compared with permissible limits. (auth)

36761 SELECTION OF SECTIONAL PLANE AND TRANSFORMATION OF GEOMETRIC IRRADIATION DATA IN STATIC FIELDS. Gantchew, Michael; Pandowa, Veneta (Onkologische Forschungsinstituts, Sofia). Strahlentherapie; 139: 291-7(Mar 1970). (In German).

For irradiations with static fields the set-up should allow that the cross section of the irradiation plane obtains optimal dose distributions. The conditions for it are presented and examples are discussed. It is shown that the plane section is not always perpendicular. As dose planning is done with geometric dosimetric data within an oblique plane, transformation formulas are presented to transfer data from the patient's coordinate system to the irradiation coordinate system. (auth)

Radiation Protection

Refer also to abstracts 36453 and 37281.

36762 (JUL-603-ST, pp 204-8) ACTIVITY AND SHIELDING: A COMPUTER PROGRAM FOR THE DETERMINATION OF RADIATION INTENSITY AND SHIELDING REQUIREMENTS IN REACTOR ACTIVATION. Rohloff, F.; Crommen, G. (Kernforschungsanlage, Juelich (West Germany). Zentralabteilung Strahlenschutz). (In German).

To determine the shielding requirements after activation analysis, a computer program for all radioisotopes is developed. The program supplies the health physicist within a few minutes with all pertinent data about shielding of the activated sample, type of radiation emitted, and average half life. This supply of information is particularly important in the case of activated samples that contain several radioactive isotopes. Several practical applications are discussed and tabulated for activation of an iron sample containing cobalt, manganese, chromium, nickel, molybdenum, and thallium. (H.B.G.)

Safety Procedures

Refer also to abstract 36747.

36763 (JUL-603-ST) CENTRAL DIVISION OF RADIATION PROTECTION ANNUAL REPORT, 1968. Broecking, D.; Heinzelmann, M. Jacobs, H.; (and others) (Kernforschungsanlage, Juelich (West Germany). Zentralabteilung Strahlenschutz). Aug 1969. 274p. (In German). Dep. CFSTI (U. S. Sales Only).

Twenty-six separate abstracts were prepared for the twenty-six sections of the report. (H.B.G.)

For abstracts of individual sections see: 36168, 36410–36412, 36537, 36555, 36556, 36625, 36683, 36729, 36730, 36744–36749, 36753–36755, 36762, 36764, 36766, 37527, 37528, and 38579.

36764 (JUL-603-ST, pp 153-6) MONITORING OF OPERATIONS: SERVICING OF EQUIPMENT. Rolnik, W. (Kernforschungsanlage, Juelich (West Germany). Zentralabteilung Strahlenschutz). (In German).

Statistical incidence of failures in various personnel monitoring devices is tabulated. Predominantly, breaks occur in connecting wires, indicating that commercial equipment does not conform to normally occurring tension and torsion. Difficulties with vacuum tubes and transistors are briefly discussed. Economical factors, reliability, and ease of handling are evaluated for German and foreign equipment. (H.B.G.)

36765 PROBLEMS OF ASSESSING RADIATION INJURY. Grossmann, Horst (Bezirkskrankenhauses, Karl-Marx-Stadt, Ger.). Strahlentherapie; 139: 314-15(Mar 1970). (In German).

A case of leukemia attributable to a Chaoul irradiation is reported. It should be stressed that every disease caused by radiation is not only due to untrained personnel, but also to non-qualified doctors. In order to combat the exaggerated and non-controllable phobia, it is necessary to examine critically every disease apparently caused by radiation. (auth)

Legal Aspects

36766 (JUL-603-ST, pp 119-28) MONITORING OF OPERATIONS: ADMINISTRATIVE PROBLEMS. Sauermann, P. F.; Broecking, D. (Kernforschungsanlage, Juelich (West Germany). Zentralabteilung Strahlenschutz). (In German).

Bookkeeping for reactor fuel elements, radioactive material, and radioactive waste is discussed. Legal problems concerning transportation of such material within the KFA, as well as outside, are presented. Four diagrams display the various administrative procedures involved in the transportation of fissionable material, radioactive substances, and waste material. (H.B.G.)

Medicine

Refer also to abstract 36647.

Protective Substances

Refer also to abstracts 36692, 36740, 36802, 36808, 36816, 36828, and 36851.

36767 PROTECTIVE AGENTS MODIFYING BIOLOGICAL EFFECTS OF RADIATION. Carr, C. Jelleff; Huff, James Edward; Fisher, Kenneth D.; Huber, Tyron E. (Federation of American Societies for Experimental Biology, Bethesda, Md.). Arch. Environ. Health; 21: 88-98(Jul 1970).

Historically, chemical agents have been studied for the prevention or treatment of radiation-induced injury produced by single or short-term, high-level exposures. This review emphasizes agents that are potentially useful in protecting man against single or short-term, low-level sublethal radiation doses. A number of radiation-effects modifying agents have been discovered that exhibit protective effects against whole-body irradiation. Unfortunately, few of these substances have been evaluated in preventing injury against lower sublethal doses of radiation that are pertinent to public health interests. There is a need for improved screening methods for evaluating agents that modify the biological effects of this type of radiation exposure. (auth)

36768 THE ACTIVITY OF CYTOCHROMOXIDASE IN THE EPITHELIUM OF VILLI OF THE JEJUNUM OF MICE IN RADIATION SICKNESS AND RADIOPROTECTIVE ACTION OF CYANIDE. Strelina, A. V. (Central Scientific Research Roentgeno-Radiological Inst., Leningrad). Byull. Eksp. Biol. Med.; 69: No. 3, 33-6(Mar 1970). (In Russian).

In experiments on albino mice subjected to whole-body x-ray irradiation in a dose of 600 R regular changes in the activity of cytochromoxidase reflecting the integral ratios of the principal energy-reproducing systems occurred. In the epithelial cells of villi of the jejunum the most significant inhibition of the referred to enzymatic activity coincides with the peak of "intestinal death"; restoration of the activity is achieved in 15 days. Dynamics of alterations of cytochromoxidase are observed if prior to irradiation one administers sodium cyanide, which caused a sharp inhibition of the enzymatic activity at the time of irradiation and a relatively rapid restoration in 4 days. In the author's opinion, radioprotection with cyanide is caused by the formation of an inactive complex of cytochromoxidase-CN conducive to an increase of radioresistance of the chain of electron transfer and, in this connection, the survival of animals. (auth)

36769 EFFECT OF ANTIOXIDANTS ON SHEEP IN RADIATION SICKNESS. Usov, G. P. Veterinariya; 45: 61-3(Aug 1968). (In Russian).

Selenium compounds and Vitamin E act as radioprotectors by slowing down oxidative processes and activating sulfur-containing aminoacids. This problem was further studied by comparing the effect of these materials with that of a known radioprotective agent, unithiol in the case of radiation sickness of sheep. Sodium selenide was injected into the test animals in doses of 0.3 to 0.4 mg/kg body weight; the Vitamin E was administered intramuscularly. The animals were exposed to 600 R of x radiation. An increase of the body temperature, increased reactivity to external stimuli; faster rate of respiration and an increased sensitivity of the skin were noted immediately after the exposure; these symptoms were attributed to the functional depletion of the central nervous system and the slowing down of the vegetative centers. Sheep treated with selenium compounds and with Vitamin E before irradiation exhibited less epilation than the control animals; this was explained by the protection of unsaturated fatty acids against oxidation. Sheep treated with unithiol did not exhibit any epilation, acting probably as a thio-group donor to cystine and cysteine in the wool fibers. (TTT)

36770 STUDIES ON BIOLOGICAL RADIATION PROTECTION. XC. RADIOSENSITIVITY OF MICE FOLLOWING PREVIOUS RADIATION EXPOSURE AS WELL AS ADMINISTRATION OF RADIOPROTECTIVE SUBSTANCES. Langendorff, H.; Langendorff, M.; Moenig, H. Strahlentherapie; 139: 336-46(Mar 1970). (In German).

Albino mice were irradiated by the split dose method in order to study the influence of the first dose (preconditioning dose) on the radiosensitivity of the animals. It was noted that doses up to 162 R increased the radioresistance to a second dose during several weeks. Administration of cysteamine or serotonin prior to the preconditioning dose of 162 R was without any effect; after 325 R, however, radioresistance increased. Cysteamine before the second dose increased survival. Serotonin reduced survival, when compared to the survival resulting from a preconditioning and second dose combined with cysteamine or serotonin. (auth)

36771 EFFECTS OF FOOD PRESERVATION PREPARATIONS O_5SURVIVAL RATE OF RATS FOLLOWING WHOLE-BODY IRRADIATION. II. LACTIC ACID, LACTOSE, SORBIC ACID, SODIUM PHOSPHATE. Peters, Karl; Peters, Rosemarie (Univ., Tuebingen, Ger.). Strahlentherapie; 139: 362-71(Mar 1970). (In German).

When lactic acid, lactose, sorbic acid, or sodium phosphate is added to water, in concentration between 10 to 0.02 mg/ml, modifications of survival of whole-body irradiated rats are observed depending on the substance and its concentration. Relations are noted between the quantity taken in and the kind of substance, age, weight, and sex of the animal, as well as radiation dose and time elapsed after irradiation. (auth)

Radiodiagnosis

Refer also to abstracts 36549, 36593, 36594, 36596, 36646, 36657–36659, and 36731.

36772 (UCLA-12-778) DELAYED BRAIN SCANNING WITH ^{99m}Tc PERTECHNETATE FOR IMPROVED TUMOR DETECTABILITY. Gates, G. F.; Dore, E. K.; Taplin, G. V. (California Univ., Los Angeles. Lab. of Nuclear Medicine and Radiation Biology). [1969]. Contract AT-04-1-GEN-12. 16p. Dep. CFSTI.

The results of ^{99m}Tc pertechnetate brain scans performed during the first hour following tracer injection and of rescanning selected patients one to twenty-four hours later are described. Eighty brain tumors were found among the nearly 1500 patients who had brain scans performed during the two year period. Seventy-four had a tissue diagnosis and in the remaining six, diagnoses were established by clinical, scan, and neuroradiological findings. Forty had both early and delayed scan examinations and in 15 the early scans were normal or equivocal. Fourteen of these 15 became positive upon delayed examination. Twenty-six nondiagnostic to moderately positive early scans increased in their degree of abnormality upon delayed examination. The detectability of brain tumors improved from 80 percent with routine early scanning to 93 percent by rescanning selected patients later. The optimal time for delayed scan examination is three-four hours following tracer injection. (auth)

36773 INFORMATION CONTENT OF X-RAY IMAGES, POSSIBILITY OF STANDARDIZED EVALUATION, AND PREPARATION FOR COMPUTERIZED DIAGNOSIS. Oelssner, W. (Karl-Marx-Univ., Leipzig). Radiol. Diagn.; 10: 538-40(1969). (In German).

The procedure for evaluation of x-ray pictures is discussed; the following method is suggested; an overall review is made without being influenced by the case history and by striking roentgenologic changes; all deviations from the norm are noted; the radiological findings are interpreted taking the clinical history into consideration; the radiological findings are properly described and a diagnostic evaluation made. In the future, the findings will be transferred either to a questionnaire or to a punch tape for computer evaluation. In many cases, as in stomach ulcers, computer analysis is unnecessary. In findings that have many differential diagnostic possibilities, however, computer analysis is of great value. The establishment of a central data bank is suggested. (H.B.G.)

36774 TECHNICAL PRINCIPLES FOR THE ASSESSMENT AND MAINTENANCE OF IMAGE QUALITY IN PRACTICAL X-RAY DIAGNOSIS. Krieg, R. (Justus-Liebig-Univ., Giessen, Ger.). Radiol. Diagn.; 10: 437-46(1969). (In German).

To obtain standardized x-ray pictures, voltage and current were measured at the input and output of both generator and x-ray tube. Also determined was the energy distribution in the primary x-ray beam. The equipment employed was inexpensive enough to allow general application as a first step toward standardization. Method and findings are depicted in twelve pictures and diagrams. (H.B.G.)

36775 RELATIONSHIP BETWEEN SPACIAL FREQUENCY SPECTRUM, IMAGE CONTENT, AND DIAGNOSTIC RADIOLOGY. Angerstein, W. (Forschunginstitut fuer Tuberkulose und Lungenkraukheiten, Berlin). Radiol. Diagn.; 10: 485-90(1969). (In German).

Theory and practical application of the modulation-transmission function are discussed. An x-ray picture is scanned linearly by a photo cell and the photo current, as determined by film density, is electronically subjected to a Fourier analysis. The frequency data are stored in a computer and compared with previous established normal values. By subtraction, pathological deviations are established. Another method displays the transmission function on a television screen. If, for instance, a normal chest x-ray picture is taken and subsequently a contrast medium is injected into the pulmonary artery, the two transmission functions are electronically subtracted and, thereby, a clear picture of the arterial system alone is obtained. (H.B.G.)

36776 PROBLEM OF OPTIMIZING IMAGE-PRODUCING SYSTEMS FOR RADIOLOGY. Tautz, M. (Staedtischs Klinikum, Berlin). Radiol. Diagn.; 10: 491-506(1969). (In German).

By means of the modulation-transmission function, optimal conditions for obtaining informative x-ray pictures are studied. Effects on the spacial frequency transmission are studied with respect to focus size, motion of the biological object, and distortions by the film-intensifier foil combination. Four practical clinical situations are analyzed. Pictures of the metatarsal bones require extreme accuracy as to fine details; results are presented in six diagrams. Abdominal pictures during pregnancy demand minimal exposure to the gonads and to the embryo; therefore, high intensifier foils are required as represented by five diagrams. Chest x-ray pictures are confronted with the high speed of cardiac motion that may range up to 300 mm/second; therefore, high-energy x-ray, short exposure time, and intensifier foils are necessary as depicted in four diagrams. Mammography requires soft-energy radiation in combination with intensifier foils as shown by two diagrams. (H.B.G.)

36777 OPTIMIZING OF IMAGE-PRODUCING SYSTEMS AND DIAGNOSTIC METHODS IN RADIOLOGY. FIRST DISCUSSION CONTRIBUTION. Oelssner, W. (Karl-Marx-Univ., Leipzig). Radiol. Diagn.; 10: 515-19(1969). (In German).

Possibilities to improve radiodiagnostic procedures are discussed. It is proposed to characterize the x-ray energy not by the kV but by the half-value layer; this method would make the

radiation comparable for different types and makes of x-ray equipment. The scatter radiation should be reduced to less than 20% of the useful beam; several approaches are suggested. To obtain optimal contrast, the x-ray dose should be measured in milliroentgen/second directly in front of the picture producing system. (H.B.G.)

36778 OPTIMIZING OF IMAGE-PRODUCING SYSTEMS AND DIAGNOSTIC METHODS IN RADIOLOGY. SECOND DISCUSSION CONTRIBUTION. Liess, G. (Humboldt-Univ., Berlin). Radiol. Diagn.; 10: 521-2(1969). (In German).

At the present time, almost every radiologist uses his own diagnostic method. Standardization and, possibly, automatization can only be reached as a cooperative effort between radiology and industry. As a first step, the establishment of tolerance requirements by the clinicians is suggested. Gall bladder pictures taken with 10 kV difference at various institutions showed no noticeable variation in quality. It is concluded that a tolerance of 4 to 5 kV is sufficient for standardization. (H.B.G.)

36779 PROBLEMS OF TERMINOLOGY IN THE EVALUATION OF X-RAY IMAGES. Boeck, G.; Richter, K. (Medizinische Univ., Berlin. Medizinische Poliklinike der Charite, Berlin). Radiol. Diagn.; 10: 523-4(1969). (In German).

It is suggested that radiological terminology be standardized especially with respect to computer application. The image content should be separated into analytical and synthetic components. Analytically, changes in intensity should be described as metal-like, bone-like, and soft-tissue like. Geometrical form and size should be indicated in the metric system and commonly used terms like cherry-size and small-apple size should be avoided. Synthetically, the roentgenologic findings must be interpreted diagnostically and must be integrated into the total clinical picture. With increasing importance of cybernetics, the relationship between form and function becomes more precisely determinable. (H.B.G.)

36780 ROLE OF VISUAL CONDITIONS IN THE EVALUATION OF X-RAY IMAGES. Dalicho, W. A. (Krankenhauses Kuechwald, Karl-Marx-Stadt, Ger.). Radiol. Diagn.; 10: 525-7(1969). (In German).

Optimal interpretation of an x-ray picture is reached when it has a brightness between 5,000 and 10,000 asb; when the observer is adapted to the mean brightness of the picture; when the photometric contrast in the visual field does not exceed 30 to 1; when the observer is focused on the detail to be studied; and when the observer is not fatigued. At the present time, the weakest link in diagnostic radiology is fluoroscopy because of low brightness, unfavorable spectral distribution and cumbersome handling. (H.B.G.)

36781 ASSESSMENT OF IMAGE QUALITY FROM THE STANDPOINT OF THE RADIOLOGIST. Richter, K. (Medizinische Univ., Berlin. Medizinische Poliklinike der Charite, Berlin). Radiol. Diagn.; 10: 529-37(1969). (In German).

Objective and subjective factors affecting the interpretation of x-ray pictures are reviewed. Treated are picture quality and x-ray doses, picture quality and information content, physical factors influencing picture quality, and picture quality and diagnostic interpretation. Twenty references are given. (H.B.G.)

36782 AUSTRALIAN SOCIETY OF NUCLEAR MEDICINE SECOND ANNUAL MEETING, SYDNEY, 1970. Summary of Papers Accepted for Presentation to the Scientific Sessions, Held at Randwick, New South Wales, 12th and 13th February 1970. Sydney; Australian Society of Nuclear Medicine (1970). 18p. (CONF-700208).

Summaries only, of 17 pages are presented. They deal primarily with scintiscanning methods, but an abstract on a radionuclide power source and one on radioisotope uptake in body organs are included. (auth) (Australia)

36783 RADIOACTIVE LUNG SCANNING IN DIAGNOSIS OF PULMONARY DISEASE. Inzinna, J. F. J. Med. Soc. N. J.; 66: No. 1, 13-14(1969).

Scintillation scanning of the lungs using radioiodinated macroaggregated albumin is a simple and safe method for determination of pulmonary perfusion. Its most useful application appears to be in the early detection of pulmonary emboli. Valuable information can be obtained in certain types of malignancies and other space occupying lesions, in various forms of chronic lung disease, and as a screening test when surgical procedures are contemplated. Serial scans to determine the effects of surgery or chemotherapy can also be done and the scan could always be supplemented by pulmonary arteriography. (Excerpta Med.)

36784 ^{125}I-LABELLED FIBRINOGEN TEST ADAPTED FOR ROUTINE SCREENING FOR DEEP-VEIN THROMBOSIS. Kakkar, V. V.; Renney, J. T. G.; Nicolaides, A. N.; Friend, J. R.; Clarke, M. B. (King's Coll. Hospital, London). Lancet; 1: 540-1(14 Mar 1970).

A new apparatus for the detection of deep-vein thrombosis, using the ^{125}I-labelled fibrinogen test, is described. Forty patients were studied and results with the new method (ratemeter) and the older method (requiring radioactive counting and calculations) were compared. Counts with the two methods correlated well, and both methods detected deep-vein thrombosis in the six patients in whom this complication developed. There was no false-positives. It is suggested that the ^{125}I-labelled fibrinogen test with the ratemeter is a suitable method for the routine screening of at-risk patients. (auth) (UK)

36785 CUTANEOUS BLOOD FLOW IN PSORIASIS MEASURED BY ^{133}Xe CLEARANCE. Nyfors, Allan; Rothenborg, Hans W. (Finsen Inst., Copenhagen). J. Invest. Dermatol.; 54: 381-5(May 1970).

The radioactive, freely diffusible, inert gas ^{133}Xe was used to study the cutaneous blood flow in 15 cases of fresh, untreated psoriasis and in 10 normal subjects. In normal skin and in uninvolved skin in psoriatics the blood flow proved to be approx. 6.5 ml/100 g tissue per min, while in the psoriatic plaques it was twice this value, viz., about 12 ml/100 g tissue per min. It was concluded that the gross erythema, the slightly elevated skin temperature (by 1.5°C), and the microscopic evidence of vascular changes in psoriatic lesions are in fact based upon increased blood flow; that, according to the results of the present technique, the cutaneous tissue of uninvolved skin in psoriatics does not have a greater blood flow than cutaneous tissue of controls; and that the present method of determining the cutaneous blood flow following intracutaneous injection of ^{133}Xe, calculating from the first, rapidly falling slope of the flow curve, is well-suited for clinical use, as the measurement need not be done for more than 10 to 15 minutes in order to calculate the cutaneous blood flow during the traumatic phase immediately after the injection. (auth)

36786 ANATOMIC LOCALIZATION IN ISOTOPE PHOTOSCANS. THE RADIOPHOTOSCAN. Galkin, Benjamin M.; Mansfield, Carl; Franco, Joan; Birney, Gail; Kozielski, Joseph W. (Thomas Jefferson Univ. Hospital, Philadelphia). Radiology; 96: 195-8(Jul 1970).

When interpreting radioisotope scans, it is occasionally desirable to accurately relate the scan to anatomic structures. A method is described for simultaneously generating conventional photoscan and a radiophotoscan, i.e., a single film containing both radiographic image and photoscan accurately positioned relative to each other. Conventional x-ray equipment and a 3-inch or 5-inch scintillation magnascanner, with no significant modification, are utilized. (C.H.)

36787 USE OF A WHOLE-BODY COUNTER IN BONE SCANNING. Gardner, Horace B.; Johnston, Gerald S. (Walter Reed Army Inst. of Research, Washington, D. C.). J. Surg. Oncol.; 1: 325-33(1969).

A new method of whole-body assay for abnormal concentration of bone-seeking radioactive isotopes, in this instance ^{85}Sr was performed in 40 patients with excellent results. The instrument used is a whole-body counter which employs 18 NaI (Tl) crystals (9 by 2 in.) in a 3 × 6 array which permits bilateral comparisons of isotope concentration, crystal-to-crystal comparisons, and body area comparisons. Very small amounts of isotope (1–10 μc, ^{85}Sr) are required. In 40 patients, one false positive and no false negative findings were obtained. The findings were confirmed by scintiscanning and x-ray studies. (auth)

36788 RENAL COMPUTER SCINTIGRAPHY. Imhof, H.; Dorau, F.; Umek, H.; Czembirek, H.; Frischauf, H. (Univ., Vienna). Fortschr. Geb. Roentgenstr. Nuklearmed.; 112: 655-64(May 1970). (In German).

In order to investigate local function in the kidneys, data from an Anger-scintillation camera were fed into a computer. The method was described and a number of typical examples, from a total material of 31 investigations, were discussed. In three cases, abnormalities were diagnosed which would have been missed by traditional methods. (auth)

36789 X-RAY FINDINGS FOLLOWING TRAUMATIC FAT EMBOLISM OF THE LUNGS. Stelzig, H.-H.; Heckrodt, J.; Haas, J. P. (Johannes-Gutenberg-Univ., Mainz). Fortschr. Geb. Roentgenstr. Nuklearmed.; 112: 584-90(May 1970). (In German).

The diagnostic value of plain chest radiographs for traumatic fat emboli in the lungs is discussed. Nineteen fatal cases with

gross fat embolisation were reviewed retrospectively; the radiological findings in the lungs were compared with the macroscopic and histological appearances at autopsy. In 17 cases it was possible to demonstrate nodular or infiltrative lung changes, particularly hemorrhage, edema, and atelectasis. There is no definite correlation between the extent of embolization and the frequency, type and distribution of the foci in the lungs. It is concluded that radiology can make no contribution to the diagnosis of traumatic fat emboli. (auth)

36790 PROCEDURE FOR MULTICOLOR RECORDING OF SCINTIGRAMS OBTAINED WITH A GAMMA-RAY CAMERA. PART 1. PRINCIPALS AND EXPERIMENTAL RESULTS OBTAINED WITH A SIMULATED RADIATION MODEL. Huehn, E. A.; Fassbender, C. W. (Staedtische Krankenanstalte, Dortmund, Ger.). Fortschr. Geb. Roentgenstr. Nuklearmed.; 112: 686-8(May 1970). (In German).

The method is designed for the simplification of quantitative analysis in the interpretation of gamma camera scans. By means of a color photographic device, individual iso-intensity zones can be registered. Suggestions are made for the best clinical use, keeping in mind the statistical factors. These were obtained by experiments simulating various levels of activity distribution by means of a wedge source. (auth)

36791 EXPERIENCE WITH THE DIAGNOSTIC APPLICATION OF RADIOACTIVE ISOTOPES IN LIVER DISEASES. Loginow, A. S. (Institut fuer Therapie, Moscow). Deut. Z. Verdau.- Stoffwechselkrankh.; 28: 181-2(1968). (In German).

Applied were ^{131}I Rose Bengal and radioactive gold. Radioactivity was measured simultaneously in liver, blood, and intestinal tract. This method permitted differential diagnosis between hepatitis and gall stone occlusion. For localized diseases scintigraphy was utilized. In combination with spleeno-porto angiography the radioisotope procedures allowed differential diagnosis between chronic hepatitis and cirrhosis. Radioactive isotopes proved to be of great value for diffuse and localized liver diseases. (H.B.G.)

36792 DIAGNOSIS OF SPECIFIC TUMORS BY BRAIN SCINTIGRAPHY EXPERIENCE WITH RIHSA. Heilmann, H.-P.; Kunft, H.-D. (Staedtische Krankenhauses, Berlin). Fortschr. Geb. Roentgenstr. Nuklearmed.; 112: 664-75(May 1970). (In German).

An attempt was made to diagnose type of tumor by means of color scans following ^{131}I-RISA. Experience with 141 patients indicated that it is possible to determine the biological nature of the tumor. Glioblastomas and metastases showed definite increases in activity over the tumor after 24 hours, benign tumors, such as meningiomas and oligodendrogliomas, showed similar activity after two and after 24 hours. Arterio-venous angiomas were best shown after two hours, there being hardly any activity at 24 hours. Among histologically confirmed cases, correct differentiation was achieved in 75% of cases. Because of the high radiation burden, the examination should be carried out only in adults and when strictly indicated. (auth)

36793 FALSE POSITIVE ^{99m}Tc HEPATIC SCINTISCAN. Volpe, J. A. (Letterman General Hospital, San Francisco); Morita, E. T.; Johnston, G. S. J. Surg. Oncol.; 1: 345-50(1969).

Instances of false positive ^{99m}Tc hepatic scintiscans resulting from objects in a right jacket pocket, the interposition of an arm between the liver and the detector, the presence of deeply indented rib margins, and the presence of kidney shadows on the posterior scan are presented. Such falso positive scans are caused by the easily shielded 140 kev gamma photon ^{99m}Tc. The problem may be accentuated by the tomographic effect of the various focused rectilinear scanners currently in use. By anticipating these problems and by promptly repeating scans following corrective measures, misinterpretation of the ^{99m}Tc hepatic scintiscan may be avoided. (auth)

Radiotherapy

Refer also to abstracts 36476, 36759, 36833, 36839, 36842, 36843, 36845–36847, 38000, and 38014.

36794 INTRACORPOREAL VASCULAR PROSTHETIC BLOOD IRRADIATOR. Hellerstein, Lewis J.; Johnston, Lloyd W. (to Secretary of the Air Force). U. S. Patent 3,505,991. 14 Apr 1970. Filed 13 Feb 1968.

The design of the prosthetic blood irradiator consists of a tube for replacing a segment of vein or artery. It has a window and passes through a double shield having a hollowed out portion communicating with the window. A radioactive element is disposed in the hollowed out portion and is movable by a positioning means whereby the amount of radiation received by the blood may be varied. (auth)

36795 MEGAVOLTTHERAPY, INDICATIONS, AND RESULTS. Becker, J. (Univ., Heidelberg). Strahlentherapie; 139: 261-70 (Mar 1970). (In German).

Development of megavolt therapy, dosage and fractionation problems are reviewed and the various therapeutic indications as well as the differences of megavolt therapy in relation to orthovolt therapy are discussed. Moreover, results are discussed with regard to the therapy applied to 17637 patients at Heidelberg University Clinic for radiotherapy since 1954, i.e., megavolt therapy with hyperenergetic electrons and ultrahard X-rays of the betatron, as well as therapy with telecobalt units. (auth)

36796 COMPARISON OF ^{60}Co TELETHERAPY AND HIGH ENERGY ELECTRONS FOR TREATMENT OF BLADDER CARCINOMAS. Ott, Alois (Stadt Wien-Lainz, Vienna). Strahlentherapie; 139: 280-3(Mar 1970). (In German).

The efficiency of urinary bladder tumor therapy by telecobalt or electron radiation is compared. It seems that electron therapy is more efficient. The absence of recurrence is 55% after two years, and 40% after three years for betatron electrons, and 25% after two years, and 20% after three years for telecobalt radiation. The survival after electron therapy reaches 75% after three years and only 55 to 60% for telecobalt. Moreover, lymphography allows a directed radiotherapy to lymph node metastases, which is of great value to enhance the results. (auth)

36797 RADIOTHERAPY OF RECTUM CARCINOMAS. Formusek, Arthur H.; Kuttig, Helmut; Zunter, Franjo (Univ., Heidelberg). Strahlentherapie; 139: 271-9(Mar 1970). (In German).

Ambiguity of radiotherapy of rectum carcinomas and its historical development up to megavolt therapy is reviewed. Megavolt therapy is used in cases of inoperability, for postoperative and pre-operative irradiation, for treatment of recurrences, and as palliative measure. Experiences with 415 patients, 182 of whom were treated with conventional X-rays, and 233 with cobalt-60-teleradiation, are reported. An improvement of therapy results owing to megavolt treatment is stated. A distinct correlation to the higher focal doses administered can be observed in megavolt therapy. This therapy is preferred in radiation of rectum carcinoma. (auth)

36798 BETA RADIOTHERAPY OF EUSTACHIAN TUBE SWELLINGS. 2500 CASES FOLLOWED UP FOR 23 YEARS. Bourdial, J. Sem. Hop. Paris; 45: 2871-83(14 Nov 1969). (In French).

Crowe's technic has been used since 1924. Forty-six years later and after treating hundreds of thousands of patients one may conclude that it is not dangerous. Its only purpose is to reduce acquired pathological hypertrophy of the tubal margin in the pharynx that produces obstruction responsible for ear infections. When a child has undergone adenoidectomy and there is no improvement, he risks both late fibro-adhesive deafness and chronic otitis. Among the numerous therapeutic possibilities, β radiotherapy is the treatment of choice. In a series of 2,500 patients followed up for 23 years the following results were obtained: In children there were 87% satisfactory results in relapsing otitis, and 77% satisfactory results in deafness. At this age and at this stage, treatment of tubo-tympanic deafness is preventive and curative. In adults the indications are more limited. Beta radiotherapy is no longer curative. Fibro-adhesive deafness is permanent, but treatment may prevent its aggravation. In 79% of cases it is, however, active in ear lesions associated with decompression sickness in airmen, divers, and submarine personnel. Although the main indication is in children, β radiotherapy is not a substitute for adenoidectomy. It is a harmless and efficient form of treatment in 77 to 87% of cases. If this treatment is neglected or refused, many children will become permanently deaf when they reach adult life. (auth)

36799 SIMULTANEOUS BILATERAL RADICAL NECK DISSECTION FOLLOWING HIGH-LEVEL RADIATION THERAPY. Mooney, Charles S. (Univ. of Kentucky, Lexington); Jewell, William; Greenlaw, Robert; Rush, Benjamin F. Jr. J. Surg. Oncol.; 1: 335-8(1969).

Twenty-two patients with advanced cancer in the area of the head and neck were treated by combining major curative radiation (5000–8000 rads) and a composite operation including excision of the primary lesion and bilateral radical neck dissection. The mortality and morbidity of combining these two treatment methods was quite acceptable and did not exceed mortality and complication rates for this type of operation done without prior radiation. (auth)

Radiation Effects on Animals

36800 (CALT-767-P-6-X-4) THE MITOGENIC ACTIVITY OF A C5BL/10 MOUSE TRANSPLANTABLE LYMPHOMA.

Annual Progress Report, 1970. Sanders, Bob G.; Teplitz, Ray L.; Wilkie, Margaret (California Inst. of Tech., Pasadena). Contract AT(04-3)-767. 16p. Dep. CFSTI.

Waves of host-cell multiplication were stimulated by the lymphoma in spleens of lymphoma-injected mice. This mitogenic action of the lymphoma was not limited to living cells, but was found also in x-ray inactivated cells, and in the supernatant from centrifuged suspensions of these cells. Radioisotope studies showed that the initial peak of DNA synthesis, after transfer of the mitogenic factor to the host, was correlated with the rapid expansion of the germinal centers of the host. Studies on naturally occurring antibodies included cross reactions of sera from individuals of type O with A and B red blood cells; naturally occurring antibodies of the IgM and IgG varieties of immunoglobulins were demonstrated in type O serum. Sera of chickens, horses, and man were used for studies on antigenic components common to kappa, lambda, and gamma polypeptide chains. Studies on comparison of carbohydrate-peptides from heavy chains of IgG and IgA indicated an evolutionary relationship between α and γ heavy chains. Chickens were injected with T2H bacteriophage for studies on the phage disappearance curve and the effects of antigen dosage on the onset, plateau, and decline of the antibody response. A comparative peptide map analysis was made of IgG chains from man, rhesus monkeys, baboons, sheep, and cattle. Studies were conducted on the role of a cofactor in the ability of IgM to stabilize T2H bacteriophage. The production of immunoglobulins in the thornback (elasmobranch) fish was studied. (H.L.W.)

36801 EFFECT OF PROTEIN SYNTHESIS INHIBITOR ON ACCUMULATION OF FRUCTOSE-1, 6-DIPHOSPHATE IN IRRADIATED RAT THYMOCYTES. Ohyama, Harumi; Yamada, Takeshi (National Inst. of Radiological Sciences, Chiba, Japan). J. Radiat. Res.; 10: 165-7(Sep-Dec 1969).

Ionizing radiation brings about the enhancement of phosphofructokinase reaction in rat thymocytes and a consequent accumulation of fructose-1, 6-diphosphate. Protein synthesis inhibitor, such as cycloheximide was shown to have no effect on this accumulation. Explanation of fructose-1, 6-diphosphate accumulation in terms of the stimulated de novo synthesis of phosphofructokinase could be, therefore, ruled out. (auth)

36802 X-RAY EFFECTS ON THE GLYCOLYTIC REGULATORY ENZYMES IN RAT THYMOCYTES AND THEIR MODIFICATION BY CYSTEAMINE. Yamada, Takeshi (National Inst. of Radiological Sciences, Chiba, Japan). J. Radiat. Res.; 10: 113-20(Sep-Dec 1969).

Cysteamine afforded marked protection against the effects of x irradiation on both dose-dependent accumulation of fructose-1, 6-diphosphate and ATP depletion to an approximately equivalent extent, giving the dose-reduction factor of about two. This was considered as support for the view that both phenomena are closely related and arise from a common event. Little protection was afforded under the same conditions against irradiation-induced accumulation of pyruvate and lactate in the lower dose range. Possible mechanisms underlying these phenomena are discussed. (auth)

36803 RADIATION-INDUCED CHANGES IN SOME BIOCHEMICAL PARAMETERS OF THE HEMOPOIETIC TISSUE OF RABBITS. Izak, G.; Karsai, A.; Eylon, L.; Schiffman, A. (Hadassah Univ. Hospital, Jerusalem. Hebrew Univ.-Hadassah Medical School, Jerusalem). Israel J. Med. Sci.; 6: 14-22(Jan-Feb 1970).

The nucleic acid, heme and protein synthesizing ability of rabbit hemopoietic tissue obtained from bled animals, and the effect of varying doses of radiation on these parameters were studied in vitro. Bleeding produced a substantial increase in the synthesizing activity of the bone marrow cells as compared to control animals. Radiation doses ranging from 1,000 to 10,000 rad inhibited all bio-chemical functions in the marrow cells studied, the effect being roughly proportional to the dose of radiation employed. The synthesis of DNA was found to be the most vulnerable, while the utilization of glycine for heme production was the least affected process. In reticulocytes large doses of radiation were found to interfere with heme synthesis, while the amino acid incorporation activity into protein was not affected. (auth)

36804 CHARACTERISTICS OF THE ULTRASTRUCTURE OF MITOCHONDRIA AND THEIR RELATION TO OTHER CELL STRUCTURES AFTER EXPOSURE TO AN ELECTROMAGNETIC FIELD. Zufarov, K. A.; Shneyvays, V. B. (Tashkent Medical Inst.). Arkh. Anat., Gistol. Embriol.; No. 12, 22-6(1969). (In Russian).

Parenchymatous cells in rat livers showed a sharp increase in the number of very large mitochondria with depressions or invaginations of the membrane 24 hours after exposure to an electromagnetic field. Around these depressions membranes of the rough endoplasmic reticulum were found, with free ribosomes forming polysomes (containing 5 to 15 ribosomes). These changes were also observed in the liver cells of some control animals. The altered mitochondria in both experimental and control rats were characterized by disorientation, increase in number and size of cristae, and appearance of tubular and polyhedral cristae unusual for liver mitochondria. Some possible functions of the invaginations are discussed. (JPRS)

Invertebrates

Refer also to abstracts 36737 and 36738.

36805 (ORO-3546-9) INFLUENCE OF THE PHYSICAL STATE OF CHROMATIN ON NUCLEIC ACID AND PROTEIN SYNTHESIS AND ON RADIATION SENSITIVITY OF CELL DIVISION. Progress Report. Gaulden, Mary Esther (Texas Univ., Dallas. Southwestern Medical School). 28 May 1970. Contract AT(40-1)-3546. 17p. Dep. CFSTI.

Hanging drop cultures of grasshopper embryos (Chortophaga viridifasciata) were exposed to x radiation at doses of 32 R, 500 R, or 1000 R and the uptake of ^{3}H-thymidine by neuroblast cells exposed during the various stages of the cell cycle was investigated. Neuroblast cells exposed to 32 R x radiation during intermediate and terminal late prophase did not incorporate ^{3}H-thymidine and cells irradiated during initial late prophase exhibited radioinduced ^{3}H-thymidine uptake only when the cell was caused to revert by the irradiation. Condensed chromosomes of mid-mitotic stages did not incorporate thymidine following exposure to doses of x radiation up to 1000 R. Possible explanations for the findings are discussed. (C.H.)

36806 THE ECDYSIAL RATE OF THE GREATER WAX MOTH, GALLERIA MELLONELLA L, (LEPIDOPTERA, PYRALIDAE), AFTER X-IRRADIATION WOUNDING, AND COMBINED INJURY IN THE PUPAL INSTAR. Wolbert, Peter (Univ., Wuerzburg, Ger.). Wilhelm Roux' Arch. Entwicklungsmech. Organismen; 164: 134-69(1969). (In German).

Pupae of the greater wax moth, Galleria mellonella L., were exposed to x-rays with different doses, to wounding, or to both treatments in different combintaions. The extent of damage was measured as the decrease of the frequency of ecdysis. The factors of damage after the different treatments were analyzed by partial irradiation and histological methods. The results of the histological investigation were compared with normal development of important organs of the Galleria pupa, particularly of the ecdysial glands and the corpora allata. The resistance to x-rays of the Galleria pupa increases about twentyfold during the seven days of the pupal instar. In a given pupal age and after a given dose the radiation damage depends on a direct effect on differentiable tissues and the radiation-induced inability of the hormonal system to repair such a damage. Wounding evokes a systemic response of the pupa. First this results — as indicated by histological examination of the hormonal glands — from an increased amount of juvenile hormone in relation to ecdyson. Secondly the wound possibly causes an excessive release of neurosecretion in the sense of a stress reaction. The response to wounding becomes maximal on the third and sixth day of the pupal instar. The first maximum of sensitivity on the third pupal day is thought to be correlated with a critical event on the fourth pupal day, namely the withdrawing of the epidermis from the pupal cuticle. The second maximum of sensitivity on the sixth pupal day coincides with the second maximum of activity of the corpora allata at the end of the fifth day. A combination damage is always followed by a relatively large decrease of the ecdysial frequency, independent of the effects of the single injuries. The intervals between and the sequence of the treatments have no influence. The combination damage is particularly an amplification of the effect of wounding caused by radiation. (auth)

36807 SPECIFICITY OF ALLOGRAFT REACTION IN EISENIA FOETIDA. Chateaureynaud-Duprat, Pierrette (CNRS, Talence, France. Faculte des Sciences, Bordeaux). Transplant. Proc.; 2: 222-5(Jun 1970).

Pieces of body wall and coelomic cells were transplanted to earthworms (Eisenia foetida) from different colonies. Immunity reactions following the transplants indicated that individuals of different genetic races were incompatible. The influence of the nervous system on regeneration and immune reactions was studied by removing the cerebral ganglia; it was found that regeneration was weaker and delayed. Weak irradiation (500 R) resulted in stimulation of the nervous system; the first reactions against body wall allografts were nonspecific and interfered with regen-

erative processes and with specific immunologic rejection reactions. It is suggested that the nervous system controls nonspecific protection reactions of the worms. (H.L.W.)

Vertebrates

Refer also to abstracts 36700, 36703, 36706, 36709, 36710, 36714–36716, 36719–36725, 36736, and 36768–36771.

36808 (AD–702721) THE EFFECT OF SYMPATHOMIMETIC AMINES ON RADIATION-INDUCED TOLERANCE TO PENTOBARBITAL IN THE RAT. Miletich, D. J.; Bradley, S. L.; Strike, T. A. (Armed Forces Radiobiology Research Inst., Bethesda, Md.). Dec 1969. 16p. (AFRRI-SR-69-27). CFSTI.

Male Sprague–Dawley rats were given 250-, 500-, or 1000-rad midline tissue doses of 300 kVp x rays. Twenty-four hours post-irradiation the acute toxicity of sodium pentobarbital was determined in these animals. Rats receiving 500 and 1000 rads demonstrated an increased tolerance to sodium pentobarbital, but no change in toxicity was observed in animals given 250 rads. This radiation-induced increase in pentobarbital tolerance was similar in degree to that observed in unirradiated rats treated with amphetamine, a known barbiturate antagonist. However, when rats received amphetamine as well as 1000 rads of x rays no increased tolerance to sodium pentobarbital was observed. Four days of reserpine treatment prior to irradiation also abolished the radiation-induced increase in sodium pentobarbital tolerance. These results suggest that increased central norepinephrine levels are responsible for the radiation-induced increase in tolerance to pentobarbital. (auth) (TAB)

36809 (NYO–3777-33) RADIATION CARCINOGENESIS. Progress Report IV, May 1, 1969–April 30, 1970. (New England Deaconess Hospital, Boston, Mass. Cancer Research Inst.). Contract AT(30-1)-3777. 18p. Dep. CFSTI.

Studies of acute γ radiation injury to one of a parabiosed pair of rats yielded irrefutable evidence of the repair of radiation injuries. The mechanisms of repair processes are under study. The incidence of neoplasms in parabiotic rats surviving for a long time following acute lethal γ irradiation of one member of the pair was compared to that of the nonirradiated partner and parabiosed controls. A high incidence of endocrine gland tumors was observed in the irradiated rats. The carcinogenic effects of continuous external γ irradiation throughout intrauterine life, the suckling period, or both, were studied in mice exposed to total doses ranging from 280 to 2100 rad delivered at dose rates up to 30 rad/day from a ^{60}Co source implanted in the thorax of the dam. The number and variety of both benign and malignant solid tumors were greatly increased in the irradiated mice in comparison to untreated mice of the same life span. The incidence and type of leukemia were determined for mice exposed over several generations to continuous γ radiation delivered at the dose rate of 22.8 rad/year. (C.H.)

36810 (NYO–3970-30) KINETICS OF CELLULAR PROLIFERATION IN THE SEMINIFEROUS EPITHELIUM UNDER CONTINUOUS IRRADIATION. Fabrikant, Jacob I. (Johns Hopkins Univ., Baltimore, Md. Dept. of Radiological Sciences). 6 Oct 1969. Contract AT(30-1)-3970. 23p. (CONF-691021–3). Dep. CFSTI.

From 12th International Congress of Radiology, Tokyo, Japan.

Under continuous γ irradiation, cell renewal during spermatogenesis in the mouse could achieve a near-steady state of cell population at a dose rate of 1.8 rads/day or less for at least 15 weeks by limited mechanisms of compensatory cell proliferation. Changes in the patterns of spermatogonial cell population kinetics indicated there was some reserve of proliferative capacity, but the extent to which these changes were caused by decreasing the cell cycle time of a precursor subpopulation in the type A cell compartment, or the bringing-in of a potentially proliferative dormant A_0 cell population, is not, as yet, clearly understood. Both mechanisms may be important in maintaining the steady state of spermatogenesis. Autoradiographic data indicated that there was a delay in the flow of spermatogonia in each proliferative compartment from the post-synthetic period into cell division, associated with a decrease in the duration of DNA synthesis, but with a normal cell cycle time. There was a slight differential radiosensitivity among spermatogonia affecting proliferation. Even at dose rates of less than 2 rads/day, spermatogonia may be very sensitive to radiation death. The main reason for this low tolerance to continuous irradiation may very well be the lack of compensatory mechanisms regulating spermatogonial cell reproduction. (C.H.)

36811 (NYO–3970-39) CELL POPULATION KINETICS IN THE SEMINIFEROUS EPITHELIUM UNDER CONTINUOUS LOW DOSE RATE IRRADIATION. Fabrikant, Jacob I. (Johns Hopkins Univ., Baltimore, Md. Dept. of Radiological Sciences). 21 May 1970. 17p. (CONF-700610–2). Dep. CFSTI.

From 4th International Congress of Radiation Research, Evian, France.

Under continuous γ irradiation, cell renewal during spermatogenesis in the mouse could achieve a near-steady state of cell population at a dose rate of 1.8 rads/day or less for at least 15 weeks by limited mechanisms of compensatory cell proliferation. Changes in the patterns of spermatogonial cell population kinetics indicated there was some reserve of proliferative capacity, but the extent to which these changes were caused by decreasing the cell cycle time of a precursor subpopulation in the type A cell compartment, or the bringing-in of a potentially proliferative dormant cell population, is not, as yet, clearly understood. (auth)

36812 (NYO–3970-41) CELL PROLIFERATION IN LYMPHOID TISSUE AND THE SEMINIFEROUS EPITHELIUM UNDER CONTINUOUS IRRADIATION. Progress Report, June 1, 1969–May 31, 1970. Fabrikant, Jacob I. (Johns Hopkins Univ., Baltimore, Md. Dept. of Radiological Sciences). Contract AT(30-1)-3970. 44p. Dep. CFSTI.

Results are reported from investigations on cell proliferation dynamics in the immunohematopoietic tissues of the thymus and spleen and the seminiferous epithelium of young mice and rats under continuous low dose rate γ irradiation. Work on cellular response and cell population kinetics of these various renewal tissues of the body has continued and both continuous irradiation and acute irradiation are being used to study the capacity of the systems to change their patterns of cell proliferation and differentiation under stress. These investigations are providing information on cellular control mechanisms regulating proliferation and differentiation in the hematopoietic tissues and the seminiferous epithelium in relation to the extent to which a steady state of cell population compatible with function can be established and maintained under continuous exposure, the dose rates which can be tolerated, the processes involved in collapse, and compensatory mechanisms, such as changes in the patterns of cellular proliferation and cellular control mechanisms, which may be necessary for the maintenance of tissue homeostasis and the regulation of cell reproduction. (46 references) (C.H.)

36813 (NYO–3970-45) RADIATION EFFECTS ON CELLULAR PROLIFERATION AND DIFFERENTIATION IN THYMUS LYMPHOCYTES. Fabrikant, Jacob I. (Johns Hopkins Univ., Baltimore, Md. Dept. of Radiological Sciences). 8 Aug 1969. Contract AT-(30-1)-3970. 13p. Dep. CFSTI.

Results are reported from studies on cell population kinetics in lymphoid tissue in the thymus of mice. Quantitative autoradiographic studies were made following repeated labeling with ^3H-thymidine. The pattern of lymphopoiesis in the thymus under continuous irradiation indicated there is evidently some capacity for maintenance of a steady or near-steady level of cell population of less than normal size. Electron microscopic studies showed that under continuous exposure at 45 rads/day, after an initial decrease in thymus cellularity, the tissue could maintain a steady level of cell population for at least four weeks or more. After two weeks, there was a progressive shift in the cell size distribution to a greater proportion of the more primitive forms, increased levels of labeling in all lymphoid cell compartments, but particularly in reticular cells and medium lymphocytes, and an increased rate of accumulation of labeled small lymphocytes. These changes in the patterns of cellular proliferation were associated with a narrowing of the distribution of cell cycle times in all lymphoid cell types, but with little change in the overall mean generation time. It appeared that, normally, lymphopoiesis in the thymus occurs almost as fast as possible, but under the additional stress of continuous irradiation there is still a considerable reserve of proliferative capacity and compensatory mechanisms involving altered patterns of cellular proliferation can occur to maintain the cell population, albeit at a reduced level. (C.H.)

36814 (ORO–3832-8) LONG TERM EFFECTS OF PRENATAL X-IRRADIATION AND GAMMA-IRRADIATION ON CEREBRAL CORTEX. Technical Progress Report, June 1, 1969–May 31, 1970. Brizzee, Kenneth R. (Tulane Univ., Covington, La. Delta Regional Primate Research Center). May 1970. Contract AT(40-1)-3832. 21p. Dep. CFSTI.

The effects of exposure of prenatal or neonatal rats to various doses of single, fractionated dose, or continuous whole-body γ or x radiation on the development of the cerebral cortex were investigated. The kinetics of brain cell development in non-irradiated and 100 R γ-irradiated rats were studied in timed pregnancy rats injected with ^3H-thymidine on the 13th gestation day followed by counts of labeled metaphase nuclei in cells of the primordial ependymal layer. The irradiation techniques and methods used for

the preparation of brain tissues for light and electron microscopic examination are described. Histological examination of brain tissues showed that residual radiation damage in cerebral hemispheres increased slowly between doses of 25 R and 75 R, but increased rapidly following exposure to higher doses. The brains of animals exposed to fractionated doses of 100 R plus 50 R and 100 R plus 100 R γ radiation showed much less residual damage than animals subjected to the same total dose administered by a single exposure. Hypothermia induced at various times during the irradiation schedule caused changes in the radiation response. Abstracts of published papers that report the results of previous studies on the teratological effects of various doses of γ or x radiation on rats are included. (C.H.)

36815 (RLO-2225-T-2-1) LOW-LEVEL CHRONIC IRRADIATION OF SALMON. Annual Progress Report. Donaldson, Lauren R. (Washington Univ., Seattle. Coll. of Fisheries). 20 Jun 1970. Contract AT(45-1)-2225. 22p. Dep. CFSTI.

Since 1964 the eggs of salmon have been exposed to chronic γ radiation at dose rates ranging from 0.5 R/day to 20.0 R/day during the incubation period (71 to 81 days) and the fingerlings produced from the irradiated eggs, together with controls, marked and released to migrate to the sea. Data are summarized on the mortality, incidence of morphological abnormalities, weight, and length of fingerlings and of adult salmon that returned to the home pond during a five-year period. No definite evidence of radiation damage has been observed. (C.H.)

36816 INVESTIGATIONS ON HISTOCHEMICAL CHANGES IN EXPERIMENTAL CORNEAL LESIONS INDUCED WITH ULTRAVIOLET RADIATION AND ON PREVENTION OF PHOTOPHTHALMIA. Hamerski, W. (Medical Academy, Lublin). Pol. Med. J.; 8: 1469-76(1969).

In experiments involving exposure of the cornea to ultraviolet radiation we observed that considerable changes in the histochemical reactions developed in the cornea during the asymptomatic period of 6 hours following exposure. These changes particularly involved the SH groups and SS bonds. Visible changes also occurred in the activity of alkaline phosphatase, acid phosphatase, ATP-ase and 5-nucleotidase. Instillation of cysteine solution into the conjunctival sac prior to irradiation prolonged the asymptomatic period and decreased the intensity of photophthalmia. Instillation of glycerol completely prevented the development of photophthalmia. (auth)

36817 STIMULATION OF THROMBOCYTOPOIESIS IN IRRADIATED MICE. Ebbe, Shirley; Stohlman, Frederick Jr. (St. Elizabeth's Hospital, Boston. Tufts Univ., Boston). Blood; 35: 783-92(Jun 1970).

Platelet depletion in mice, by injection of heterologous antiplatelet serum (APS), resulted in apparent stimulation of megakaryocytopoiesis as evidenced by a subsequent over-compensation of the level of circulating platelets. Injection of APS immediately before or after exposure to sublethal x radiation or a day after exposure appeared to modify the response to radiation. Radiation-induced thrombocytopenia was neither as severe nor as prolonged in animals so treated as in irradiated controls. More chronic thrombocytopenia at the time of irradiation, however, appeared to increase the radiosensitivity of the megakaryocytic system. (auth)

36818 CHANGE IN DOSE-SURVIVAL TIME RELATIONSHIP AFTER X-IRRADIATION DURING EMBRYONIC DEVELOPMENT IN THE FISH, ORYZIAS LATIPES. Hyodo-Taguchi, Yasuko; Egami, Nobuo (National Inst. of Radiological Sciences, Chiba, Japan). J. Radiat. Res.; 10: 121-5(Sep-Dec 1969).

In adults of the small fresh water teleost, Oryzias latipes, it was shown that the curve showing the relationship between the survival time after x irradiation and the dose applied is similar in shape to that reported for laboratory rodents. Small doses of x rays did not exert acute lethal effect on the fish, while very large doses caused death instantaneously. Between these extremes, some dose ranges were distinguishable from others by the difference in effects on the post-irradiation survival time. The survival times of adult fish irradiated with various doses within the range 4 kR to 32 kR were approximately the same. When the fish were irradiated during early embryonic stages, such dose-independent range as demonstrated in adult, was not demonstrated and dose-survival time relationship curves for the embryos were simpler in shape than those for adults of the same species. A possible explanation for the change in the relationship during embryonic development is discussed. (auth)

36819 MORTALITY AND BODY WEIGHT RESPONSE OF MALE WISTAR RATS IN THE LETHAL X-RAY DOSE RANGE. Tsuchihashi, Sohsaku; Enomoto; Yoshikazu; Yamada, Takeshi; Nakamura, Wataru; Eto, Hideo (National Inst. of Radiological Sciences, Chiba, Japan). J. Radiat. Res.; 10: 133-8(Sep-Dec 1969).

Experiments were conducted to determine the $LD_{50/30}$ of Wistar strain male rats, aged 72 to 112 days, bred in the National Institute of Radiological Sciences. The animals were irradiated at eight exposure levels between 600 and 900 R with x rays at the rate of 23.5 R/min. Probit analysis of mortality data yielded an $LD_{50/30}$ of 761.6 ± 31.8 R. The body weight of the animals decreased gradually after irradiation, reaching a minimum value at the 4th day after exposure. The body weight of 30-day survivors showed a second minimum value at the 18th to 21st day after irradiation. (auth)

36820 EFFECT OF A SUPRALETHAL DOSE OF NEUTRON-GAMMA RADIATION ON THE VISUAL SENSITIVITY OF RHESUS MONKEYS. Treadway, J. E. Waco, Tex.; Baylor Univ. (1969). 114p.

Thesis.

Recent studies utilizing electrophysiological, histological, and histochemical approaches suggested that irreversible selective retinal damage occurs soon after exposure to 2,000 rads or more of ionizing radiation. On the basis of this evidence of radiation induced alterations to the red cell population, predictions have been made concerning functional scotopic vision following irradiation. This experiment was conducted to ascertain the effect of exposure to 3,500 rads neutron-gamma radiation on visual sensitivity. Six male rhesus monkeys were trained to respond to visual cues on a two-lever forced-choice discrete avoidance task with shock serving as the aversive reinforcement. The stimulus intensity of the cues ranged from photopic through scotopic levels, and cue positions were presented in a random sequence. A modified version of von Bekesy's technique for measuring auditory thresholds was used in determining visual sensitivity. Incremental steps were made up or down the circumscribed stimulus intensity range depending upon detection of the cue. If a subject made a correct response, the stimulus intensity on the subsequent trial decreased; if the subject made an incorrect response, the stimulus intensity increased. Thus, the subjects drove the intensity of the cues up or down depending on their ability to detect the cues, and visual sensitivity was plotted as a function of time. Following collection of baseline performance data, each subject was exposed to approximately 3,350 rads neutron-gamma radiation, and performance data following irradiation was gathered. The results failed to indicate irreversible impairment of scotopic vision following irradiation. The primary performance consequence of radiation exposure was a decline in response probability which was most severe immediately after irradiation. Several explanations were advanced to account for the apparent discrepancy between the results of this study and those of previous investigators. The most plausible interpretation appears to be that although the rod cell population was possibly extensively damaged following irradiation, an adequate number of rods remained sufficiently intact to allow detection of cues within the intensity range used in this study. (Diss. Abstr.)

36821 ROLE OF CHALONE IN THE CONTROL OF THE BONE MARROW STEM CELL POPULATION. Kirk, J.; Orr, J. S.; Forrest, J. (Western Regional Hospital Board, Glasgow). Math. Biosci.; 6: 129-43(1970).

The bone marrow stem cell population is a basic undifferentiated self-maintaining population that supplies the three main circulating blood populations. The mitotic replenishment of the stem cells under the control of their specific mitotic inhibitor, chalone, forms the system under discussion. The mathematical formulation of this system is presented as two nonlinear simultaneous differential equations. These equations are solved with the aid of an EAL 680 analogue computer, giving an exact solution by continuous integration. The behavior of the mathematical formulation is compared with the experimental results for the recovery of the stem cell population in polycythemic mice after x irradiation. Under various conditions, different forms of oscillatory solution are found, and the forms of these solutions are examined by sensitivity analysis. The agreement of the formulation with experiment is shown to be unsatisfactory unless the concept of a controlled variable cycle transit time is invoked. This effect could be of great importance in the stability of the sequence and timing of the control mechanisms of more complex systems. (auth)

36822 EFFECT OF X IRRADIATION ON DIFFERENTIATION OF CELLS OF SQUAMOUS-CELL CANCER IN MICE. Frankfurt, O. S. (Inst. of Chemical Physics, Moscow). Vop. Onkol.; 16: No. 3, 55-8(1970). (In Russian).

Squamous-cell carcinomas were transplanted in mice and after 10 days ^{3}H-thymidine was injected. One hour following the injection of ^{3}H-thymidine tumors were given single irradiation in a dose of 2000 to 3000 R. Differentiation of the labelled cells was recorded on radioautographs. During 7 days after irradiation

there was no division of the labelled cells and differentiation of cells was observed in 60 per cent. The proportion of differentiated cells in a population during the first days after irradiation was increased, and then decreased. To the 7th day after irradiation differentiation of basal cells has ceased and foci of proliferative basal cells were noted in the tumor. In daily irradiation with 600 r the proportion of differentiated cells in a population was increased after the 5th and reduced after the 10th session of radiation. Probably, in basal cells, in which the synthesis of specific proteins started prior to irradiation, the process of differentiation is being completed, while in other cells this process does not start at all after irradiation. Stimulation of the differentiation process in these cells could enhance the effect of radiation on tumor. (auth)

36823 QUALITATIVE AND QUANTITATIVE STUDIES ON THE EFFECT OF INTERNAL ^{60}Co IRRADIATION ON THE TESTES OF BLACK AND WHITE MICE. Srivastava, Pratap N.; Rao, A. Ramesha (Univ. of Rajasthan, Jaipur, India). Strahlentherapie; 139: 323-9(Mar 1970).

Young adult male black (C 57) and white (Swiss albino) mice were intraperitoneally injected with ^{60}Co (1.5 μCi/g body weight). The animals were autopsied at intervals of 1, 3, 7, 15, and 30 days post injection, There was no elicitation of testicular atrophy or histological sterilization at this dose level. Qualitatively, there was no disruption in the cellular pattern in different cyclic stages of the epithelium. Cell death of early spermatogonial stages was encountered together with exfoliation in some tubules. Quantitative analysis indicated comparatively high radiosensitivity of spermatogonia (Types A and B) and resting primary spermatocytes in both strains. White mice appeared to be comparatively more sensitive to internal ^{60}Co irradiation than black mice. The Sertoli and Leydig cells did not display any apparent changes in their cytomorphology. (auth)

36824 IMMEDIATE REACTIONS OF ISOLATED GUINEA PIG AND RAT URINARY BLADDER TO X-IRRADIATION. Michailov, Michael Ch. (Gesellschaft fuer Strahlenforschung mbH, Neuherberg, Ger.). Strahlentherapie; 139: 330-5(Mar 1970).

Preparations of the urinary bladder of guinea pigs and rats react to x-irradiation with a reversible contraction. The threshold dose is about 5 kR at a dose-rate of 20 kR/min. Size and duration of the radiation induced reaction is dose and dose-rate dependent. A tachyphylactic reaction is observed. After a total dose of 200 to 300 kR (fractionated or continuous irradiation) the bladder contracts irreversibly. (auth)

36825 OBSERVATIONS OF REDUCED RADIOSENSITIVITY FOLLOWING PREVIOUS SUBLETHAL RADIATION EXPOSURE OF CHICKEN EMBRYOS. Wendt, Ernst (Univ., Bonn). Strahlentherapie; 139: 372-8(Mar 1970). (In German).

With massive preliminary irradiations, the radiosensitivity of chicken embryos to subsequent irradiations was determined. A decrease of sensitivity occurred after 10 hours, reached a maximum after 20 to 30 hours and vanished after 40 hours. It seems that this protective effect resulted from an activation of aspecific cellular defense mechanisms. (auth)

36826 EXPERIMENTAL STUDY OF POST-IRRADIATION RENAL PATHOLOGY IN RABBITS. Grewal, S.; Lal, K.; Chakravarti, R. N. (Inst. of Medical Education and Research, Chandigarh, India). Indian J. Med. Sci.; 23: 602-6(Nov 1969).

An experimental study on rabbits was undertaken to investigate the effect of x irradiation on the kidneys. The experiment comprised four groups of animals, six animals in each group. Bilateral and unilateral renal irradiation and pulmonary irradiation after shielding the kidneys were used. The fourth group served as normal controls. The irradiation was given by a 250 kV conventional Siemens equipment and a total dose of 3000 R over the skin in a period of 11 days was given to each animal. The animals were observed for a period of 3 months. The parameters of the study were general clinical condition, body weight, ocular fundus, urinalysis and estimation of blood urea and postmortem examination of the kidneys and other tissues histologically. It was observed that roentgen rays cause direct trauma to the renal parenchyma leading to functional as well as structural disturbances. The main pathological feature in the kidneys is diffuse fibrosis that can be taken as a factor leading to renal ischemia. However, evidence of persistent raised blood pressure in the form of retinal changes or diffuse arteriolar lesions was not observed. (auth)

36827 PROTRACTED INFLUENCE OF TRITIATED THYMIDINE ON DEVELOPMENT OF CHICK EMBRYOS. Schuppler, J. (Univ., Vienna). Protoplasma; 68: 457-70(1969). (In German).

The distribution of ^{3}H thymidine and control media injected into incubated chicken eggs was examined with respect to localization and time. The rate of dying off of the embryos was greatest when the ^{3}H thymidine was injected into the amniotic cavity, and smaller when applied to the yolk. An alteration of the morphology of the amnion was found and to a lesser extent damage to the embryo was observed. An increase of malformations above the normal in developing embryos was not recognized. (auth)

36828 RADIOPROTECTIVE EFFECTS OF THIAMINE AT ALKALINE CONDITION. Titani, Yoiti; Takahashi, Tomoo; Yamaguchi, Kenji (Shionogi and Co., Ltd., Osaka). Radioisotopes (Tokyo); 19: 290-3(Jun 1970).

The radioprotective effects of alkaline thiamine were investigated in Escherichia coli and mice. Escherichia coli B/r was irradiated with 30 kR of ^{60}Co γ rays at a dose rate of 1,000 R/min, while the mice received 800 R of whole-body irradiation with ^{60}Co γ rays. The radioprotective effects of the sulfhydryl form of thiamine and its derivatives were compared with those of AET. (F.M.M.)

36829 ULTRASTRUCTURAL CHANGES IN BONE MARROW LYMPHO-MONOCYTIC AND MYELOBLASTIC ELEMENTS IN WHOLE-BODY IRRADIATED RATS UNDER DIFFERENT CONDITIONS. Notario, Antonia; Bobbio-Pallavicini, Enrico; Scaglione, Pietro; Marciano, Salvatore; Rodolico, Riccardo (Univ., Pavia, Italy). Haematologica (Pavia); 54: 269-89(1969). (In Italian).

The behavior of the cellular ultrastructures of lymphoblastic, histiomonocytic and granuloblastic bone marrow cells was examined following whole-body irradiation of rats. The lymphocytic cells showed an evident numerical decrease, without evident changes in the ultrastructural components. The histiomonocytic and granuloblastic cells, however, showed an enlargement of the ergastoplasmatic structures, the presence of vacuolization and above all a pronounced degeneration of some components of the mitochondria. (auth)

36830 STEM CELL IN PERIPHERAL BLOOD: A STUDY BY PARABIOSIS OF IRRADIATED AND NONIRRADIATED ANIMALS. II. HEMATOPOIESIS OF IRRADIATED RAT HAVING A NON-IRRADIATED PARABIONT. Kawai, Toru (Okayama Univ., Japan). Acta Med. Okayama; 23: 377-86(Oct 1969).

The existence of stem cells of myeloid and erythroid cells in circulating blood and their morphologic entity were investigated in peripheral and bone marrow cells of x-irradiated parabionts having non-irradiated partners joined by vascular parabiosis. The following results were obtained: The control rats exposed to 1000 R x ray did not show any sign of recovery of hemopoiesis in bone marrow even 8 days after irradiation. In the bone marrow and spleen of lethally irradiated animals having a non-irradiated partner in parabiosis, precursor cells of granulocytes and erythrocytes appeared first 4 days after conjugation irrespective of the days after irradiation, and hemopoiesis was restored completely on the sixth to the seventh day. The results indicated that the circulating blood has stem cells that can dedifferentiate and transform into precursor cells of the myeloid and erythroid cells within 3 days under adequate conditions. On the basis of the morphologic observations on the peripheral blood of the parabiosis and non-irradiated rats that revealed non-specific cells, a discussion was made on the possibility that some atypical lymphoid cells can serve as stem cells of myeloid and erythroid cells. (auth)

36831 STUDY OF BRAIN AND SERUM PROTEINS IN ANIMALS EXPOSED TO MICROWAVES. Grigor'yan, D. G. (Central Inst. of Health Resort Medicine and Physical Therapy, Moscow). Vop. Kurortol., Fizioter. Lech. Fiz. Kul't.; No. 6, 510-13(1969) (In Russian).

Experiments on rabbits exposed to microwaves (0.006 w/cm^2 and 0.04 w/cm^2) in 10 daily sessions of 10 min each showed that the microwaves sharply decreased serum albumins while increasing the alpha- and beta-globulins. Exposure to microwaves also increased the beta-globulins in the gray matter of the brain, while increasing the gamma-globulins (only when nonthermal doses were used). The protein fractions in the white matter of the brain changed only slightly, while fractions in the hypothalamus did not change at all, regardless of the intensity of the microwaves. (JPRS)

36832 DYNAMICS OF TRANSFORMATION OF THE VENOUS BED AFTER DISRUPTION OF THE BLOOD OUTFLOW DURING ACUTE RADIATION SICKNESS. Khudayberdyiev, R. I.; Bakhadyrov, F. N. (Tashkent State Medical Inst.). Arkh. Anat., Gistol. Embriol.; No. 10, 64-7(1969). (In Russian).

The blood flow in the femur of 60 rabbits, disrupted by resection of the femoral, sciatic, and deep femoral veins, was restored within 65 to 75 days after the operation. This was accomplished by 2 or 3 vessels connecting the femoral vein to the central end of the inferior gluteal vein. The distal and proximal ends of the inferior gluteal vein were connected by a direct anastomosis. The collat-

erals were formed mainly from the existing veins, that became dilated, twisted and then lengthened. At the site where the main veins were resected, vessels appeared that connected the resected ends of the veins. In another group of animals subjected to x-ray irradiation (400 R) 24 hours before the operation described above, the same pattern of transformation of the venous bed took place, but at a slower rate. The process took 115 to 120 days. (JPRS)

Man

Refer also to abstracts 36712, 36731, 36765, and 36767.

36833 STUDY ON TIME- AND RADIATION-DEPENDENT CHANGES IN THE FREQUENCY OF LYMPHOCYTES WITH CHROMOSOME ABERRATIONS IN THE CIRCULATION, FOLLOWING MULTIPLE EXPOSURES OF THE PELVIS TO γ-IRRADIATION. Tamura, Hiroaki; Sakurai, Masaharu; Sugahara, Tsutomu (Kyoto Univ.). Blood; 36: 43-51(Jul 1970).

Unstable chromosome aberrations of peripheral lymphocytes were observed during the course of γ fractionated dose radiotherapy in patients with cervical cancer. They did not increase monotonously with repeated exposures, but a plateau was observed around the second week of treatment. Similar tendencies were observed in both 72-hour and 50-hour culture experiments, although the number of aberrations was lower in the former. The distribution of numbers of dicentrics per cell fitted well the Poisson pattern throughout the period of observation. Peripheral lymphocyte counts reached a low plateau before the fifth exposure, and dropped again in the third week. It was speculated that the member exchange and/or mobilization of lymphocytes caused the nonlinear increase in chromosome aberrations. (auth)

36834 PHARMACOLOGIC AGENTS RELEASED IN ULTRAVIOLET INFLAMMATION STUDIED BY CONTINUOUS SKIN PERFUSION. Greaves, Malcolm W.; Soendergaard, Joergen (Univ. of Newcastle on Tyne, Eng.). J. Invest. Dermatol.; 54: 365-7(May 1970).

The inflammatory response to ultraviolet radiation (uv) was studied using a skin perfusion method. Perfusates from seven of 17 human subjects studied contained an unidentified smooth muscle-contracting agent, which was not histamine, kinins, serotonin, or acetylcholine. Histamine was also present, but only irregularly. Kinin activity was detected in seven of the subjects, but was probably not significant since it was also found in five of the 16 control subjects. No pharmacological activity was detected in perfusates collected during the first eight hours after irradiation. (auth)

36835 DOUBLE BLIND TEST WITH CIRCULATION STABILIZING AGENTS IN RADIOGENIC HYPOTENSION. Kleibel, F. (Univ., Heidelberg). Med. Welt; 3: 175-6(1969). (In German).

Methods of restoring the blood pressure to normal were investigated in 32 irradiated patients with radiogenic hypotension by means of a double blind trial utilizing 3 substances, K, L, and M. The patients were investigated by a total of 128 circulatory investigations in the form of Schellong's standing test. Elevation of the systolic and diastolic blood pressures by about 10 to 20 mm Hg and return to orthostasis were observed for the substances K in 21 cases, for the substance L in 12 cases, and for the substance M in 3 cases. At the end of the trial it became known that K was novadral, L another oxazolidine derivative, and M a placebo. All 3 substances had been administered orally in uniform doses of 2 tablets 3 times a day. (Excerpta Med.)

36836 CARCINOMA OF THE THYROID IN CHILDREN. Exelby, P. E.; Frazell, E. L. Surg. Clin. N. Amer.; 49: 249-59(1969).

Sixty two cases of thyroid cancer in children have been seen between 1933 and 1962. Although this is an uncommon disease in children, it has been recognized with increasing frequency in recent years. The relationship between thyroid cancer and ionizing radiation in infancy is discussed, also the increased risk in children exposed to atomic radiation. In girls there is a strong suggestion that the onset of puberty may activate, or potentiate, thyroid cancer. The delay between onset of symptoms and diagnosis is emphasized, accounting for the advanced stage of disease when many of these patients were seen. Surgery is the treatment of choice if the cancer is confined to the neck, and radioactive iodine is sometimes effective in controlling metastases. The overall prognosis in childhood is good, provided that adequate surgery is performed. The morbidity and mortality of surgical treatment is low, and children recover rapidly from this type of surgery. A cure rate of 92.1% was achieved in this series, and there is no doubt that this figure would be improved further by earlier diagnosis and treatment. (Excerpta Med.)

36837 EFFECT OF OPTICAL RADIATION ON THE HUMAN SKIN. Marciniak, Stanislaw. Wiad. Lek.; 22: 363-6(15 Feb 1969). (In Polish).

The human skin is continuously exposed to the effect of optical radiation with a wavelength of 2900 Å < λ 15,000 Å. The deepest penetration of the skin is reached at around λ = 7000 Å. The ultraviolet radiation damages some of the elements of the cell, ultimately destroying it. Experiments with rats revealed that cancer cells were caused only by radiation in the narrow wavelength range of 2800 Å < λ < 3030 Å. The effect of infrared radiation is due mainly to the generation of heat in the skin. The heat affects the functions of glands; however, the mechanism involved in this effect has not been completely clarified yet. (TTT)

36838 MISUSE AND ABUSE OF DIAGNOSTIC X-RAY. Hahn, Dennis R.; Van Farowe, Donald E. (Michigan Dept. of Public Health, Lansing). Amer. J. Public Health; 60: 250-4(Feb 1970).

Diagnostic x rays now contribute more than 50 per cent of all radiation to the general population. The reduction of all nonproductive exposure to medical diagnostic x rays is urged in order to diminish any possible genetic effects. (auth)

36839 EFFECT OF TELECOBALT THERAPY ON THE CONTENT OF LIPOPROTEIN LIPASE IN PLASMA. Novakovic, Radoslava; Bosnjakovic, Vladimir; Sobic, Vera; Vujnic, Veselin; Milutinovic, Petar (Lab. for Radioisotope Application in Medicine, Belgrade. Inst. of Radiology, Belgrade). Med. Pregl. (Novi Sad); 22: 149-53(1969). (In Slovene).

The source and plasma lipoprotein lipase (LPL) concentration were determined using plasma acceptance test (PAT) and telecobalt therapy in a group of patients with malignant diseases treated by telecobalt therapy. In the group of patients where the irradiated tissue is assumed to contain LPL (as breast cancer, lung tumor, mediastinal tumor, uterine cancer) a greater decrease of PAT is found as compared with the control group where the irradiated tissue is not assumed to contain LPL. Because the latter group at the same time received a smaller dose of irradiation it is more acceptable to consider that the decrease of PAT is related to the dose of irradiation rather than to the tissue content of LPL. It can be explained in two ways, the greater dose of irradiation produces a massive destruction and leakage of fatty substances into the plasma, blocking the capacity of LPL, or the greater dose of irradiation stimulates the inhibition factors of LPL that are present also in normal plasma. (auth)

36840 EFFECT OF IONIZING RADIATION ON UPPER RESPIRATORY TRACT AND OLFACTORY ANALYSER. Ostapkovich, V. E. Vestn. Otorino-Laringol.; 30: 51-5(1968). (In Russian).

Investigations were made on otorhinolaryngological organs, and olfaction and the pharyngeal reflex were studied in a group of persons working on accelerators of nuclear particles (first group), and with luminescent substances (second group). In the upper respiratory tract of the first group changes were found that in 42% of cases were manifested by mild circulatory disorders and in 58% — by vasomotor dystonia. In 45% of examinees a rise was noted in the thresholds of olfactory perception, especially to the odor of thymol. In the second group of persons in 88% of cases in the upper respiratory tract there were dystrophic changes; in this group of patients in 80% of cases there was seen a reduced mobility of the soft palate and lingula, in 88% of cases an absence of the pharyngeal reflex, in 96% —a stable rise of the perception threshold to the odor of thymol and in 76% —to the odor of rosemary. It was concluded that in persons working on accelerators there is a tendency toward a certain rise of vascular changes in the upper respiratory tract, whereas in the group of persons subjected to the chronic effect of radiation in the upper respiratory tract there were noted dystrophic changes that, along with shifts in other organs and systems, may be one of the symptoms of chronic radiation sickness. A stable rise of perception thresholds to thymol and rosemary odor should be considered as characteristic of the clinical syndrome of chronic radiation sickness. (auth)

36841 SIGNIFICANCE OF SOFT X RAYS FOR RADIATION RESEARCH. II. ATTEMPT AT EXPLAINING THE ADAPTATION AND CONTROL MECHANISMS AGAINST ENVIRONMENTAL FACTOR "RADIATION" IN ANALOGY TO CONCEPTS OF RESEARCH IMMUNOLOGY. Becker, Olga. Strahlentherapie; 139: 303-7(Mar 1970). (In German).

Cellular disturbances within the skin after irradiation in analogy with immunity and allergy phenomena are discussed. The energy absorbed is considered an informative modification in the cellular elements. This information is then conducted by a nervous pathway to the diencephalon, from where an order is emitted to install a regulating process. A too high demand for regulation will result in a radiation induced local lesion. Absorption of

border-rays within the skin results in an energy-transformation to be considered as a stimulus, that provokes or helps the specific organic reactions of the skin. The nervous pathway is demonstrated by the leucocyte fall observed in patients irradiated with limit-rays after a unilateral sympathectomy. (auth)

36842 DIAGNOSTIC ASSESSMENT OF RADIATION-INDUCED REACTIONS OF THE INTESTINE. Neumeister, K. (Karl-Marx-Univ., Leipzig). Deut. Z. Verdau.- Stoffwechselkrankh.; 28: 131-4(1968). (In German).

In more than 500 patients, incidence of diarrhea induced by pelvic or abdominal radiation was studied and analyzed. Type of radiation, x-rays, radium, or cobalt-60 γ did not differ significantly as to effect. The same was true for age of the patients, including 43 children. Increased intestinal reaction was observed in patients with previous abdominal surgery and in those with anemia. The diarrhea occurred during the entire period of radiation treatment; however, it was somewhat more pronounced during the first half of the treatment period. Resorption of monosaccharides and disaccharides was impaired. Administration of normal intestinal flora, Lactobacillus acidophilus, Lactobacillus bifidus, Escherichia coli, reduced the incidence of diarrhea. (H.B.G.)

36843 REACTION TO RADIATION OF LUNGS AND PLEURA IN PATIENTS WITH MAMMARY CARCINOMA. Notter, G.; Lindell, D.; Vikterloef, K. J. Fortschr. Geb. Roentgenstr. Nuklearmed.; 112: 571-84(May 1970). (In German).

One hundred fifty-five patients who were operated for carcinoma of the breast and 24 patients with inoperable breast carcinomas were examined radiologically and by scanning six months after conclusion of radiation treatment. 4,000 to 5,000 rad were given over 25 to 35 days to the paramediastinal region. 49 out of 179 (27%) showed definite evidence of fibrosis radiologically. Scanning revealed reduced activity, indicating an abnormal circulation, in 40 out of 87 cases examined (46%). Following doses of 4,000 to 6,000 rad, there were fibrotic changes at the apices, which increased with increasing radiation dose. Altogether, 43 out of 175 patients (24%) showed radiological evidence of fibrosis and 44 out of 90 (48%) showed evidence of abnormal circulation on scanning. The higher frequency of positive findings in the scanning series is partly due to selection of cases. In many patients there was disagreement between the radiological and radioisotope findings because of the different type of information revealed by these methods. Using irradiation with electrons, it was shown that radiation pneumonitis can be avoided if the depth dose is calculated, taking into account the thickness of the chest wall, and if, using 8.8 MeV electrons, the 50% isodose curve is placed 5 mm. external to the pleura. (auth)

36844 INVESTIGATION ON ANTI-LEUKOCYTE ANTIBODIES IN SERA OF IRRADIATED PATIENTS. Suzuki, Kenzo (Tottori Univ., Japan). Yonago Acta Med.; 13: 133-44(Aug 1969).

The presence of anti-leukocyte antibodies was investigated in 53 irradiated patients by means of the leukocyte agglutination test and the anti-human globulin consumption test. The leukocyte agglutination test was positive in 6 cases of 44 patients (13.6%), and the AHG consumption test was positive in 25 cases of 53 patients (47.2%). Both tests were negative in all the controls at all times. These circulating antibodies may obviously have been caused by irradiation, because these patients were not treated with any blood transfusion. Although there is no evidence of direct damage by the antibodies to leukocytes or the bone marrow, it may be concluded that there is some correlation between leukopenia and the presence of antibodies, inferable from the statistical differences of numbers of cases with leukopenia in groups with and without antibodies, and that anti-leukocyte antibodies might be one of the causes of leukopenia in radiotherapy. (auth)

36845 CLINICAL PICTURE OF MYELOPATHY DEVELOPING AFTER RADIATION THERAPY. Okhrimenko, N. N.; Bakhur, V. T.; Likhachev, Yu. P. Zh. Nevropatol. Psikhiat.; 69: 674-9 (1969). (In Russian).

Four cases (2 of which were verified) of lesions of the spinal cord, as a result of radiotherapy of malignant tumors of the pharynx and larynx, are presented. The neurological symptomatology in these patients developed from 3 to 12 months after radiotherapy. The clinical picture in one case at the onset of the disorder was expressed in Brown-Sequ-syndrome that was then substituted by tetraplegia. The second case was characterized by a mixed paresis of the upper and lower extremities with fibrillar and fascicular tics. In the third case there was a paraparesis of the lower extremities with dissociated disturbances of sensitivity. The fourth case was characterized mainly by a disorder of the descending tract and substantia gelatinosa of both trigeminal nerves. The most prominent factor in the pathogenesis of radiation lesions of the spinal cord is the secondary ischemic changes in the cord, caused by vascular disturbances. In differentiating this disorder with metastatic tumors the following conditions should be held in mind: normal CSF tests, an absence of x-ray vertebral changes, slow development of spinal symptomatology, and the correspondence of the level of spinal lesions to the zone of radiation. (auth)

36846 STUDIES OF DELAYED SEQUELAE FOLLOWING IRRADIATION DURING CHILDHOOD. Feine, U.; Fendel, H.; Gnutzmann, B. (Univ., Tuebingen, Ger.). Strahlentherapie; 139: 308-13(Mar 1970).

Between 1925 and 1965, 1301 children received radiation therapy for benign diseases. With the aid of a questionnaire, the subsequent story for each child was obtained for 979 cases. For 96.7% a time lapse of more than 10 years after the treatment was involved. If no thyroid cancer was observed, the number of goiters was increased in children irradiated in the neck region, more than when irradiated elsewhere. One uterus cancer and one breast cancer were observed, but no leukemia. Sex ratio was not modified significantly in the F1 generation. (auth)

36847 A CASE OF A PECULIAR RADIATION AFFECTION OF THE LUNGS. Lyubushin, A. A. Arkh. Patol.; 32: No. 3, 67-70(1970). (In Russian).

A case of radiation affection of the lung in a 64-year-old patient who was x-irradiated for therapeutic purpose is described. Besides marked morphological changes characteristic of radiation injury of the lungs (radiation pulmonitis) erythrography, never described in literature before, was noted in injured cells of the alveolar epithelium. (auth)

Radiation Effects on Plants

Refer also to abstracts 36732–36735, 36739, and 36741–36743.

36848 (ORO-2066-14) EFFECTS OF GAMMA AND FAST NEUTRON IRRADIATION ON TREE SEED AND SEEDLINGS. Progress Report. Heaslip, Margaret B. (Morehead State Univ., Ky.). [1970]. 28p. Dep. CFSTI.

Dormant and water-soaked seeds of ash, sycamore, walnut, and white oak trees were exposed to various doses of γ radiation ranging from 10 to 40 kR or fast neutrons ranging from 2 to 5 krad and the effects of moisture content of the seed on germination and seedling survival were determined. Results showed that increased water content increased the germination and survival of γ-irradiated seeds but decreased the germination and survival of neutron-irradiated seed. The effect of water on γ or neutron radiosensitivity persisted through three years of stratification or three years of dry storage at 36 to 39°F. Pine seedlings (Pinus echinata, P. strobus, and P. virginiana) were planted over radioactive waste burial trenches and the growth rate and survival of the seedlings were used as an indicator of low-level γ radiation stress. Readings of dosimeters placed five inches above the soil level and two inches below the soil level were compared with the biological data. The first aberrant growth pattern was observed in scattered specimens of Pinus strobus planted two years previously. Tree seedlings from γ-irradiated seed of black oak, black walnut, buckeye, red bud, sweet gum, sycamore, and white ash were transplanted to open pasture or secondary forest locations. The tree seedlings exposed to the additional stress of the secondary forest environment had a more limited growth than those in the pasture. Seeds from red bud trees grown from γ-irradiated (10 kR) seeds were exposed to doses of 10, 15, or 20 kR γ radiation. The germination and survival rate of the X_2 generation was significantly lower than controls. Dormant seedlings of black walnut, white ash, and white oak were exposed to γ radiation at doses of 3 to 12 kR and their growth and survival were compared to that of seedlings irradiated in the spring while physiologically active. Results showed that white ash was the most γ resistant and white oak the most γ sensitive of the three species. White ash and white oak were both most radiosensitive when physiologically active. Survival of all three species decreased as the level of irradiation increased. (45 references.) (C.H.)

36849 PARTIAL SUPPRESSION OF THE LOCALIZING MECHANISM TO TOBACCO MOSAIC VIRUS BY UV IRRADIATION. Loebenstein, G.; Chazan, R.; Eisenberg, M. (Volcani Inst. of Agricultural Research, Bet Dagan, Israel). Virology; 41: 373-6(Jun 1970).

The effects of uv irradiation of hypersensitive plant hosts on the multiplication of tobacco mosaic virus (TMV) were studied in cucumber (Cucumis sativus) cotyledons and tobacco (Nicotiana glutinosa) leaves. Virus titers in the irradiated plant tissues were measured at various time intervals following innoculation with the virus. Results showed a partial suppression of the localizing mechanism for TMV induced by uv irradiation. (C.H.)

36850 STUDY OF THE EFFECTS OF DIFFERENT LEVELS OF CARRIER-FREE ^{89}Sr IN THE SOIL ON THE GROWTH AND DIFFERENTIATION OF PLANT ORGANS. I. THE GENERAL EFFECT ON PEA AND LETTUCE ROOTS. Younis, A. F. (Univ. of Alexandria, Egypt). Isotope Radiat. Res.; 1: 63-9(Oct 1968).

Germinated pea and lettuce seeds were grown in soils containing different amounts of ^{89}Sr to give beta activities of 3, 6, 9, 12, 15, 18 and 21 μc/g soil at the time of planting. After 5 weeks all plants were harvested and examined morphologically and histologically. The effective threshold level of beta activity in the soil for the growth and differentiation of tissues in the two plants seems to lie somewhere between 9 and 15 μc/g soil; below this level there was some activation of growth, and above it a definite retardation took place. The formation of the nodules on pea roots was reduced at 3 μc and 6 μc and completely suppressed at 9 μc or more. The histological features of the pea roots suggest that the threshold level of beta activity for cell division is apparently lower than that for differentiation. (auth)

36851 INVESTIGATING THE RADIATION TOLERANCE OF YEASTS IN SOLUTIONS OF HIGH CARBOHYDRATE CONCENTRATION. Kiss, I.; Farkas, J. Elelmiszertudomany, 3: 93-100 (1969). (In Hungarian).

Yeast strains were isolated from natural and cryoconcentrated apple juice treated by ionizing radiation. The osmophilic character of the pure cultures, the survival curves of the radiation-treated yeasts and the D values were determined. It was established that some of the isolated strains had D values (90 to 120 krad) that approximated those of bacterial spores. The inhibitory threshold concentration of fructose for some yeast strains was between 43 and 64%. The percentage of spoilage was studied as a function of fructose concentration, water activity and dose level. It was found on the whole that the physiological activity and growth of the yeasts decreased with decreasing water activity. As regards the combined effect of the water activity of the nutrient and of radiation treatment it was established that the growth of the investigated yeast strains decreased with the increase of fructose concentration and dose level. Among the osmophilic yeasts the growth optimum of a Zygosaccharomyces nadsonii strain was found to be near 30% fructose concentration in spite of irradiation. At this concentration fructose appears to provide some protection for the yeast. (Hung. Tech. Abstr.)

36852 GROWTH OF HIGHER FRESHWATER PLANTS AFTER IRRADIATION WITH GAMMA-RAYS AND FAST NEUTRONS. Leinerte, M. P. (Inst. of Biology, Riga). Latv. PSR Zinat. Akad. Vestis, No. 11, 68-72(1969). (In Russian).

Doses of fast neutrons greatly exceeded physically equivalent doses of γ rays in their biological effect on duckweed (Lemna minor L.), elodea (Elodea canadensis Rich.), and foxtail (Myriophyllum spicatum L.). All three species were more resistant to γ rays than to fast neutrons. The most resistant to both types of radiation, according to the $LD_{50/60}$, was foxtail; the least resistant, duckweed. A dose of 0.25 krad of γ rays markedly stimulated duckweed and foxtail growth, while the same dose of fast neutrons had little effect; however, elodea growth was stunted after both types of radiation. Increasing doses of both γ rays and fast neutrons markedly inhibited growth and eventually killed the plants. Duckweed and elodea were killed by doses of 100 krad of γ rays and doses of 32 krad of fast neutrons. For elodea, the lethal doses were 120 and 64 krad, respectively. (JPRS)

Radiation Effects on Microorganisms

Refer also to abstracts 36698, 36699, 36704, 36705, 36717, 36718, 36733, 36740, 36828, and 36849.

36853 INFLUENCE OF UV-INACTIVATED HVJ ON RSV RESCUE IN CULTURES OF DIFFERENT VIROGENIC MAMMALIAN CELLS MIXED WITH NORMAL SENSITIVE CHICKEN CELLS. Machala, O. (Inst. of Experimental Biology and Genetics, Prague). Folia Biol. (Prague); 16: 137-40(1970).

Different virogenic lines of Chinese and Syrian hamster cells, C57BL mouse cells transformed with Schmidt–Ruppin strain of Rous sarcoma virus, and two virogenic lines of Wistar rat cells transformed with Prague strain of Rous sarcoma virus, were used for mixed cultivation with chicken embryo fibroblasts. Before seeding, the cell mixtures were treated with uv-inactivated hemagglutinating virus of Japan (HVJ). The rescue of RSV was achieved in each mixed cell culture treated with HVJ when the mixed cells were not shaken during cell agglutination produced by HVJ. However, with the exception of Chinese hamster cells cocultivated with chicken embryo fibroblasts, no RSV rescue was obtained in the remaining mixed cell suspensions after shaking of the agglutinated cells. The amount of rescued RSV was similar when different virogenic mammalian cells transformed by the Schmidt–Ruppin or Prague strain of Rous sarcoma virus were mixed with the sensitive chicken embryo fibroblasts and treated with HVJ without shaking. (auth)

Radiosterilization and Radiopreservation

Refer also to abstracts 36510 and 36639.

36854 RADIATION-PASTEURIZATION OF SUDDENLY BOILED SHRIMP. Hwang, Yin-si; Hsu, Huan-wen; Sun, Chao-tung (Provincial Coll. of Marine and Oceanic Tech., Keelung, China). Hoken Butsuri; 5: 25-7(Mar 1970). (In Japanese).

The fresh shrimps (Erythropenaous akayebi var. sp.) were blanched three minutes in boiling 2% NaCl solution and then were sealed in polyethylene bags. The quickly boiled shrimps were irradiated by ^{60}Co and were preserved in the storage space of a refrigerator (3 to 5°C). The storage life of 0.6 megarad irradiated shrimps was extended to about 7 weeks, compared with 3 weeks for the unirradiated samples held at the same temperature. (auth)

METALS, CERAMICS, AND OTHER MATERIALS

Metals and Alloys

Refer also to abstract 36208.

36855 (AECL–3604) MATERIALS RESEARCH IN ATOMIC ENERGY OF CANADA LIMITED. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Spring 1970. 17p. Dep. CFSTI (U. S. Sales Only). AECL $0.50.

A review of research is presented on design involving brittle materials, texture and properties of Zr alloy tubing, ion bombardment damage, properties of SiC, scanning electron microscopy and examination of irradiated materials. (J.R.D.)

36856 (BNL–50236) HIGH-TEMPERATURE LIQUID-METAL TECHNOLOGY REVIEW. A Bimonthly Technical Progress Review. Volume 8, Number 1. (Brookhaven National Lab., Upton, N. Y.). Feb 1970. 40p. Dep. CFSTI.

Information on research and development programs in the US in the area of high-temperature liquid metals is presented. Reviews are presented on fluid dynamics, heat transfer, materials development, instrumentation, component development, chemical aspects, and liquid metal purification. (J.R.D.)

36857 (EUR–4474) STUDY ON THE OPTIMUM USE OF PLUTONIUM IN THE POWER INDUSTRY. Memmert, G.; Wellmann, H. (Internationale Atomreaktorbau G.m.b.H., Bensberg (West Germany)). 3 Jun 1969. 68p. (In German). Dep. CFSTI (U. S. Sales Only).

An investigation is made into the ways of using the plutonium produced in a number of different systems composed of conventional and nuclear power stations. In particular, the question arises whether this plutonium should be accumulated for later use in fast breeders or whether it should be recycled directly into the thermal reactors. The question of whether it might be useful to construct special reactors, e.g., fast converters, which have a particularly high plutonium yield but are also very costly is also considered. (auth)

36858 (ORNL–4520) FUELS AND MATERIALS DEVELOPMENT PROGRAM QUARTERLY PROGRESS REPORT FOR PERIOD ENDING DECEMBER 31, 1969. Patriarca, P. (comp.); Rucker, D. J. (ed.) (Oak Ridge National Lab., Tenn.). May 1970. Contract W-7405-eng-26. 346p. Dep. CFSTI.

Progress on research and development of nuclear fuels is summarized in 24 sections. A separate abstract was prepared for each section. (J.R.D.)

For abstracts of individual sections see: 36529, 36530, 36862–36864, 36870–36873, 36893–36896, 36922, 36940, 36945, 36951, 36952, 36970, and 36997–37001.

Corrosion and Erosion

Refer also to abstracts 36206, 36207, 36336, 38513, and 38514.

36859 (BNWL–1389) THE HIGH-TEMPERATURE COMPATIBILITY OF PROMETHIUM SESQUIOXIDE. Fullam, H. T. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jun 1970. Contract AT(45-1)-1830. 72p. Dep. CFSTI.

The long-term compatibility of Pm_2O_3 with nine different metals was evaluated at 1100°C. The metals tested were 304L SS, Hastelloy X, Haynes 25, tantalum, rhenium, tungsten, Ta–10% W, W–25% Re and TZM. The tests lasted up to 2 yr. Sm_2O_3 was used as a stand-in in most of the tests. However, enough tests were run with Pm_2O_3 to verify that the results obtained with Sm_2O_3 were applicable to Pm_2O_3. The data obtained in the tests show that oxide compatibility at 1100°C is primarily dependent on oxide purity, and that a variety of metals can be used to contain Pm_2O_3 at 1100°C provided the critical impurities (i.e., H_2O, C, organics) are removed from the oxide prior to use. Rhenium is the most compatible containment material. Oxide-metal interaction is essentially independent of time at temperature. Sm_2O_3 is a good stand-in for Pm_2O_3, and results obtained with Sm_2O_3 are completely applicable to Pm_2O_3. (auth)

36860 (CEA-N–1241, pp 121-52) CORROSION STUDIES. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). (In French).

Studies were made on: the behavior of steels and of Fe–Cr–Ni alloys exposed to water vapor; the effects of Fe^{3+} on corrosion of stainless steel Uranus 65 in HNO_3 at 98°C; the effects of heat treatments on corrosion of stainless steel 18-10 with low carbon content in HNO_3 in presence of Fe^{3+}; the behavior of austenitic stainless steel coupled to graphite in nitric medium; the behavior of titanium in nitric medium, in water, and in superheated steam; the behavior of Zircaloy-2 in nitric medium; pool storage tests of irradiated fuel elements; the formation of passive film on stainless steel containing Si in boiling 5 N nitric medium; and the application of statistical methods to corrosion studies. (France)

36861 (K-TL–81) EVALUATION OF SUBSTITUTIVE FILTER FRAMING MATERIALS IN CORROSIVE ENVIRONMENTS. Wright, C. C.; Wiggins, F. N.; Petit, G. S. (Oak Ridge Gaseous Diffusion Plant, Tenn.). 19 May 1970. Contract W-7405-eng-26. 20p. Dep. CFSTI.

Cadmium-plated steel has been used for many years as a framing material for filters because of its reasonable cost and resistance to typical atmospheres. The disposal of cadmium bearing solutions employed in plating, however, presents a health hazard. Since other steels have now become available at competitive prices, it was deemed desirable to evaluate them as possible substitutes for the cadmium-plated steel now in use. Muffler grade steel, chromized steel, zinc-coated steel and cadmium-plated steel were tested for corrosion-resistance in hydrochloric, nitric, and sulfuric acids, in acidic salt solution, and in moist, hot air. All acid solutions were 1:9 dilutions of concentrated solutions and the salt solution was 10% (w/v) at pH 3. All the solution tests were conducted at room temperature (~ 25°C). The moist air exposures were at 95°C and 100% relative humidity. These test conditions were much more severe than the framing materials would encounter in routine use. On the basis of the test results, muffler grade steel and chromized steel are considered adequate substitutes for the cadmium-plated steel presently used as filter framing material. Muffler grade steel is preferable because it is not subject to edge attack as is the chromized steel. (auth)

36862 (ORNL–4520, pp 176-86) SODIUM CORROSION STUDIES. (Oak Ridge National Lab., Tenn.).

From Fuels and materials development program quarterly progress report for period ending December 31, 1969.

Capsule tests of various V alloys were conducted to determine the effect of alloying on the reactivity of V with O in Na. As indicated by weight changes at 600°C, Cr additions to the V markedly reduced the uptake of O by the metal. Tests of V alloys in low-pressure O_2 also showed a lower contamination rate with increasing Cr content in the alloy. The results of the latter tests indicate that the O_2 pressure has a greater effect on contamination rate than does temperature between 500 and 700°C. The oxidation of 300 series stainless steels in contact with thermal insulation at 760°C is being tested in N_2 + 1% O_2 + 100 ppM H_2O. Both types 304 and 316 stainless steel were observed to form highly protective scales after a few hours in contact with this gas mixture. In a related study, the effects of a Na leak on the oxidation behavior of type 304 stainless steel in contact with insulation and this same gas mixture were examined. When Na was allowed to leak through a 0.060-in.-dia hole at 760°C, enlargement of the hole was observed and extensive oxidation of the surfaces of the stainless steel exposed to the N_2 mixture. Smaller leaks, however, plugged soon after the release of Na, and much less oxidation resulted. The thermal insulation reacted with the leaking Na to essentially the same extent in all tests. (auth)

36863 (ORNL–4520, pp 254-6) CORROSION STUDIES OF ADVANCED REFRACTORY METALS. (Oak Ridge National Lab., Tenn.).

From Fuels and materials development program quarterly progress report for period ending December 31, 1969.

Operation of a Li forced-circulation loop to evaluate the corrosion properties of T-111 in a flowing, nonisothermal system was initiated. The loop has operated 344 hr with a 1370°C maximum Li temperature. A replacement test section being fabricated for this loop will be inserted after 3000 hr of testing with the current test section. This second test section includes specimens of W as well as Ta alloys. (auth)

36864 (ORNL–4520, pp 327-37) ADVANCED MATERIALS FOR STEAM GENERATORS. (Oak Ridge National Lab., Tenn.).

From Fuels and materials development program quarterly progress report for period ending December 31, 1969.

Isothermal corrosion testing in superheated steam at 595°C for 8000 hr produced results on which the following ratings of weldments between similar metals are based (in order of decreasing resistance to general corrosion in the finish-ground condition). (1) Hastelloy X and Inconel 625 welded with themselves and Incoloy 800 welded with Inconel 82 (total scale thickness less than about

2 μm); (2) IN-102 welded with itself and type 304 stainless steel welded with type 308 stainless steel; and (3) Inconel 600 welded with Inconel 82 filler metal. The relative resistances of weldments to corrosion by superheated steam at 650°C were (1) IN-102, Inconel 625, and Hastelloy X welded with themselves (total scale thicknesses less than 3 μm); (2) Incoloy 800 welded with Inconel 82 and type 304 stainless steel welded with type 308 stainless steel; and (3) Inconel 600 welded with Inconel 82. Weldments between dissimilar metals—Hastelloy X, Inconel 625, and IN-102 joined to Incoloy 800 with themselves and Inconel 82 as filler metals—exhibited excellent resistance to corrosion by steam at 595 and 650°C; the extent of corrosion was explainable by the corrosion properties found for the individual alloys that comprised the weldments. Inconel 82 filler metal and Inconel 625, Hastelloy X, and IN-102 used as filler metals were remarkably resistant to corrosion. Hastelloy W filler metal was inferior to the others, especially when cold worked. All of the weldments tested in superheated steam were free of any preferential corrosion in the area of the fusion line after 8000 hr at 595 and 650°C. (auth)

36865 (WANL-TME-2702) EFFECTS OF TEMPERATURE AND PRESSURE ON THE HYDRIDING OF Ti–5Al–2.5Sn (ELI). Kesterson, R. L. (Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.). Jun 1970. 35p. Dep. CFSTI.

The effects of hydrogen pressures ranging from atmospheric to 600 psi and temperatures ranging from −25 to 400°F on the titanium-hydrogen reaction were studied. The Ti−5Al 2.5 Sn ELI (extra-low interstitial) alloy was found to react very rapidly with hydrogen at temperatures above 360°F if the surface was oxide free. The initial formation of surface hydrides occurred at temperatures which were inversely proportional to the pressure. As the pressure increased, hydriding occurred at lower temperatures. There was no significant effect of thin surface hydrides on the ambient tensile properties of this alloy. Ultra pure hydrogen (<1 ppM O_2) and oxide-free surfaces were required to initiate hydriding. (auth)

36866 (WAPD-Trans-130) INVESTIGATION OF THE RELATION BETWEEN THE STRUCTURE OF ZIRCALOY 2 AND ITS CORROSION BEHAVIOR IN STEAM AT 400°C UNDER PRESSURE. Lelong, P.; Perez, M. Translated for Bettis Atomic Power Lab., Pittsburgh, Pa., from Metall; 23: 897-903(1969). 18p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 24: 14648.

36867 CORROSION PHENOMENA AND CONDENSERS. Raviv, S.; Rabinovitz, E. (Nuclear Research Center, Negev, Israel). Mem. Sci. Rev. Met.; 67: 209-18(Mar 1970). (In French).

On each side of any interface separating two phases, an electrical layer of N_2O forming a dielectric may be observed. It presents points of lower resistance where corrosion is formed (interfacial or localized corrosion). The effects of HNO_3 concentration, current density, and alloy composition on the interfacial corrosion of U/ stainless steel (AISI-304), U/Al (A5), and U/Zircaloy 2 are examined. The localized or pitting corrosion is then studied and the effect of the discharge voltage and frequency of the interfacial condenser on corrosion rate is examined. (auth) (France)

36868 CORROSION OF TYPE 316 STAINLESS STEEL WITH SURFACE HEAT FLUX IN 1200°F FLOWING SODIUM. Hopenfeld, J. (Atomic International, Canoga Park, Calif.). Contract AT(04-3)-701. Nucl. Eng. Design; 12: 167-79(1970).

In a sodium-cooled reactor, the surface temperature of the cladding and the bulk liquid temperature increase along the channel as a result of heat generation in the fuel. The difference between the solubility of the corrosion products at the local surface temperature and the corresponding concentration of the corrosion products in the bulk of the sodium provides the driving force for cladding corrosion. The ability to predict this corrosion rate is a prerequisite for proper cladding design and system maintenance. A method is given for estimating the corrosion rate of the cladding when the sodium at the entrance to the fuel channel has an oxygen content of less than 5 ppM and is saturated with respect to the corrosion products. The predictions are based on experimental data of local corrosion rates which were measured along a 3.5-inch sectional cladding sample. The 55°F temperature rise along the surface of the sample was achieved by subjecting the surface to a heat flux of approximately 10^6 Btu/ft^2 hr. From the observed dependence of the local corrosion rate on the velocity (10 and 20 ft/sec) it was concluded that the corrosion rate was controlled by liquid diffusion. In order to obtain agreement of the corrosion rates derived from the theoretical equations with rates which were measured, it was necessary to use the lowest published solubility data of iron in sodium. The diffusion coefficient of iron in sodium was assumed to be that which had been published for the self-diffusion of sodium in liquid sodium. In addition to the total weight loss measurements, the preferential dissolution rates of chromium and cobalt are also presented. (auth)

Preparation and Fabrication

Refer also to abstracts 36507, 36526, and 36548.

36869 (NYO-3716-4) STUDIES OF CRYSTAL PERFECTION: TANTALUM SILICIDE AND BERYLLIUM. Technical Report, June 1, 1969–March 31, 1970. London, G. J.; Meakin, J. D. (Franklin Inst. Research Labs., Philadelphia, Pa.). Contract AT(30-1)-3716. 26p. Dep. CFSTI.

Activities in a program to develop methods for producing suitably perfect single crystals which are physically large enough to be useful as a monochromator for neutron diffraction, are summarized. Research on production of useable tantalum silicide crystals is briefly described. (J.R.D.)

36870 (ORNL-4520, pp 134-52) FABRICATION DEVELOPMENT FOR LMFBR STAINLESS STEEL TUBING. (Oak Ridge National Lab., Tenn.).

From Fuels and materials development program quarterly progress report for period ending December 31, 1969.

Ultrafine grained Type 316 stainless steel tubing was fabricated (0.250 in. outside diameter by 0.016 in. wall thickness) from two heats of materials that had 0.06 and 0.04% C, respectively. The tubing process, developed as a consequence of evaluating the temperatures of heat treatments between passes, also results in a nearly random distribution of carbide precipitate. Although this tubing is stronger at room temperature, it is weaker at 650°C than tubing processed conventionally. The biaxial stress-rupture life of the fine-grained 20% cold-worked Type 316 stainless steel tubing with carbide precipitates was shorter at 650°C than that of standard tubing from the same heat that was cold-worked 10 to 15%. The differences in the slopes of the stress-rupture curves may be due to interactions between C and dislocations. The fine-grained cold-worked tubing exhibits higher rupture strains (13 to 25%) than does the standard cold-worked tubing (generally only a few percent). The origin and significance of natural defects in tubing are being examined. Machined surfaces with a rating of 125×10^{-6} in. can result in longitudinal bore defects in the final tubing. Fabrication procedures are being devised for artificially generating flaws that resemble natural defects. Defects can be produced by electro-discharge machining notches into the tubing and then drawing it. (auth)

36871 (ORNL-4520, pp 153-63) WELDING DEVELOPMENT FOR LMFBR VESSELS AND COMPONENTS. (Oak Ridge National Lab., Tenn.).

From Fuels and materials development program quarterly progress report for period ending December 31, 1969.

The effects of heat treatment after welding on the creep-rupture properties of typical austenitic stainless steel weld metal were investigated. Studies of bead-on-plate welds showed that a wide range of macroscopic growth patterns and microscopic substructural details are attainable with the submerged-arc process. Weldments in 1-in.-thick plate are being prepared to investigate the effects of these variables on creep-rupture properties at 650°C. Scanning electron microscopy showed a correlation between fracture appearance and the solidification substructure present in weld metal. About 15 ft of weldment made by the submerged-arc process in 1-in.-thick plate is being prepared for use in a program sponsored by the Atomic Energy Commission at the U. S. Naval Research Laboratory. (auth)

36872 (ORNL-4520, pp 164-72) SHIELDED METAL-ARC WELDING FOR LMFBR COMPONENTS. (Oak Ridge National Lab., Tenn.).

From Fuels and materials development program quarterly progress report for period ending December 31, 1969.

Fourteen shielded metal-arc weldments were made with Type 308 stainless steel electrodes, each of which had a slightly different electrode coating. In three of these, only the basic types of commercial coatings (lime, lime-TiO_2, and TiO_2) varied. The deposit compositions of the remaining electrode batches (all with lime-TiO_2 coatings) were adjusted so that the effects on the mechanical properties at elevated temperatures of high and low amounts of elements such as Si, P, S, C, and B could be studied. In all cases, the deposit analyses reflect subtle differences in the electrode coatings and are within reasonable composition limits to conform to American Society for Testing and Materials (ASTM) specifications. Metallographic examination and extensive studies of bead-on-plate welds proved that there are few, if any, distinguishing features in any of the electrode batches as to their deposition performance and bead appearance. Stress-rupture data, however, indicated a definite influence of electrode coating. At

this point, only the three batches of standard electrodes and the low-Si batch of electrodes have been tested. Stress-rupture data were recorded at 650°C and stress levels of 25,000, 20,000, and 18,000 psi. The weld made with the lime-coated electrode showed a comparatively shorter rupture time than the welds from the other three batches (all of which contained some TiO_2 in the coating). All welds showed severe loss of ductility for the tests for longer times. Welds made with the standard electrodes with lime-TiO_2 coatings were characterized by a plot for ductility versus rupture time significantly lower than that for either of the other two standard batches. The low-Si weld showed the best ductility. (auth)

36873 (ORNL-4520, pp 298-307) JOINING RESEARCH ON NUCLEAR MATERIALS. (Oak Ridge National Lab., Tenn.).

From Fuels and materials development program quarterly progress report for period ending December 31, 1969.

Welds in 1/8-in.-thick Incoloy 800 sheet were made with filler wires prepared from experimental alloys. Recommended filler metals such as Inconel 62 and Inconel 82 were also used along with an electroslag remelted heat of commercial Incoloy 800. The sheet was fully restrained during welding. Cracking was observed in those welds made with the experimental alloys that nominally contained high S (0.015% S). The austenitic stainless steel experimental alloys were tested magnetically in the as-cast conditions. Homogenizing the alloys at 1150°C for 1 hr reduced considerably the magnetic character of the alloy. The effect of the presence of the high-temperature ferritic phase (ferrite) on the diffusionless transformation of austenite to martensite is being investigated. The shielded metal-arc welds were chemically analyzed. A comparison between the requested percentage of ferrite in an electrode and the percentage of ferrite predicted on the basis of chemical analysis of the weld metal indicates that high ferrite levels are difficult to achieve. The welding conditions (travel speed, current, and voltage) control the chemical composition of the deposit. Results from the study of the effect of defects showed that the yield strength at room temperature of sound weld metal was 10% higher than that of the base metal in which the fusion zone was made. Ultimate tensile strength was about 10% lower. Where evidence of discontinuities in the weld metal were revealed by radiographic examinations, the tensile properties were drastically reduced. A similar behavior was noted in short-time stress-rupture tests at 815°C. (auth)

36874 HOBSON PRODUCTION CENTRE FOR FUEL ELEMENT CANS. Astrop, A. W. Machinery (Engl.); 116: 802-6 (27 May 1970).

36875 HOBSON PRODUCTION CENTRE FOR FUEL ELEMENT CANS. Astrop, A. W. Machinery (Engl.); 116: 782-9(20 May 1970).

The application of the tangential form grinding process to fuel element cans is described. The process finishes, in one pass and in approximately 5 min, the complete periphery of stainless steel cans, 40m length, and incorporating 474 annular fins. Production problems are discussed and details are presented, with illustrations, of the Mona-Hobson tangential form grinders. Subsequent operations, performed on the ends of the can by a fully automatic special walking-beam transfer machine, are described. Some details are also given of inspection operations, and special packing procedures to protect the cans during transport. (UK)

36876 REACTION KINETICS OF THE TUNGSTEN DIOXIDE REDUCTION BY HYDROGEN. Lapostolle, Yves; Dufour, Louis-Claude (Dijon Univ., France). Compt. Rend., Ser. C; 270: 970-3(16 Mar 1970). (In French).

The preparation and the morphology of WO_2 are described. At the end of the reduction process, and metal grain size was found to be similar to that of the oxide grains and to possess a high internal porosity. The reduction rate increased inversely with the mass of the sample. The reaction kinetics were found to be linear as a function of time, between 500 and 800°C and in the hydrogen pressure range 0.5 to 200 torrs, but the induction time t_i varied inversely as p_{H_2}. The activation energy of the process was found to be nearly constant with time and equal to 33 ± 2 kcalmole^{-1} (p_{H_2} = 50 torr). Moreover, the inverse value of t_i led to a similar activation energy which did not vary with pressure between 600 and 700°C. (France)

36877 APPLICATION OF EXPLOSIVE WELDING TO ALUMINUM ALLOYS. Beghi, G.; Golinelli, P.; Montagnani, M.; Verzeletti, G. (EURATOM-CCR, Ispra, Italy). Atti Notiz. (Publ. in Met. Ital.); 24: 251-7(Oct 1969). (In Italian).

The versatility of the explosive welding technique permits it to be adapted to many diverse conditions and in numerous fields; some applications were made to Al alloys in order to examine the possibilities and to verify the operating conditions. The various parameters affecting the explosive welding process are defined. Diverse geometries of plane plate, tubes, and plugs on small tubes were examined. The metallographic examinations made on the welds of similar metals (Al-Al, Al-Al alloys, SAP-SAP) and of dissimilar metals (Al-stainless steel and SAP-stainless steel) are reported. (tr-auth)

36878 TECHNIQUE FOR VAPOUR DEPOSITION UNDER VACUUM. Euro-Spectra; 9: 25-7(Mar 1970).

The technique for vapor deposition under vacuum makes it possible to obtain layers of high purity with an adhesion that can be varied from zero to perfect bond corresponding to an interpenetration of the crystal lattice of the deposited material and that of the substrate. A differential potential is applied between the source and the substrate, which acts as an anode, causing acceleration of the electrons available in the system and ionization of the vapor. Parameters affecting the success of the technique are the substrate surface temperature and the potential applied to the substrate. Experiments were performed using aluminum, aluminum oxides, and nickel depositions on substrates. Advantages of the process are high rate of deposition, deposition of the evaporated material can be controlled to avoid deposition elsewhere in the chamber, and high-grade coatings obtained with a low vacuum of about 10^{-4} torr. (J.C.W.)

36879 FURTHER NOTES ON THE PRESSURE-SINTERING (HOT PRESSING) OF BERYLLIUM. Butcher, J. W. (International Nickel Ltd., London); Scott, V. D. Powder Met.; 13: 53-5(Spring 1970).

Previous work on the addition of an activating element, such as Si, to Be powder to improve vacuum hot pressing characteristics at 1100°C is reviewed. Two distinct mechanisms distinguishable in the hot-pressing are discussed: particle rearrangement (a combination of plastic deformation and grain boundary sliding), and interparticle diffusion (sintering). The essential requirements for full densification are shown to be the presence of an enveloping oxide around each particle, produced by heating the powder in the presence of an activating trace element, specified conditions of temperature, and of yield strength and particle size distribution of the powder. (UK)

36880 INTERACTION OF MOLYBDENUM WITH IVa METALS AND CARBON. Zhakharov, A. M.; Savitskii, E. M. (Moscow Inst. of Steel and Alloys). Izv. Vyssh. Ucheb. Zaved., Tsvet. Met.; No. 12, 96-103(1969). (In Russian).

The results of an investigation of the phase diagrams of Mo-Ti-C, Mo-Zr-C, and Mo-Hf-C are given. In the region rich in molybdenum, the diffusion of Ti, Zr, and Hf with carbon in Mo at various temperatures was studied. The solidus temperatures were used to study the microstructure and microhardness of Mo α-solid solution in the alloys of Mo-TiC, Mo-ZrC, and Mo-HfC annealed at 1970 to 2100 and 1250°C. The values of maximum diffusion of TiC, ZrC, and HfC in Mo at various temperatures are given. The isothermal cross sections of the ternary systems were determined. Additions of Ti, Zr, and Hf to the binary system Mo-C, increased the solubility of C initially, and then decreased the solubility. (tr-auth)

36881 CALCULATION OF EUTECTIC CONCENTRATION OF BINARY METALS. Vasil'ev, M. V. Izv. Vyssh. Ucheb. Zaved., Tsvet. Met.; No. 6, 90-5(1969). (In Russian).

The coordinates of the eutectic point (concentration and temperature) of the phase diagram of a metallic binary system depend on the properties of the components, the lattice structure, and the melting points. Tabulated data are given on the magnitude of the eutectic concentration of 30 binary systems. Formulas used for the determination of the data apply to the majority of systems, but exceptions include Ga-Al, Au-Si, Be-Si, Rb-Na, Au-Si, Al-Ge, Sn-Bi, and Ag-Cu. The eutectic point was shifted to higher melting in Bi-Cd, Ti-Th, Ge-Au, Cd-Pb, and Ge-Ag. The cause of such a displacement of the eutectic point is not clarified and further research is suggested. (tr-auth)

36882 POLARIZATION OF BISMUTH CATHODE DURING THORIUM PRECIPITATION FROM CHLORIDE MELTS. Vavilov, S. K.; Lebedev, V. A.; Nichkov, I. F.; Raspopin, S. P. (Ural Polytechnic Inst., Sverdlovsk, USSR). Izv. Vyssh. Ucheb. Zaved., Tsvet. Met.; No. 6, 67-72(1969). (In Russian).

A study was made on the polarization of liquid bismuth cathode in molten chlorides of sodium and potassium. The experiments were conducted in an atmosphere of argon, purified by repeated filtering over metallic titanium at 700°C and calcium at 500°C to remove traces of moisture and oxygen. The results are given of measurements of polarization of liquid bismuth and solid molybdenum cathodes in various electrolytes. The preparation of Bi-Th alloys by electrolysis in molten chlorides confirmed the postulation. The yield of thorium was 95 to 98%. (tr-auth)

36883 OBTAINING METALLIC NIOBIUM FROM Nb–Si ALLOYS BY ELECTROLYSIS. Suchkov, A. B.; Lobova, T. A.; Meerson, G. A.; Mikhina, V. N.; Safonov, V. V.; Korshunov, B. G. Izv. Vyssh. Ucheb. Zaved., Tsvet. Met.; No. 6, 56–8(1969). (In Russian).

The possibilities of obtaining niobium powder by electrorefining of Nb–Si alloys in molten chlorides and chloride–fluoride mixture are discussed. Up to 90% niobium can be extracted from the Nb–Si alloys in the chloride–fluoride electrolyte. (tr-auth)

36884 URANIUM ALLOYS FOR USE IN NUCLEAR REACTORS. Fizzotti, C.; Colabianchi, G.; Dalmastri, B.; Masperoni, A. Canadian Patent 839,182. 14 Apr 1970. Priority date 29 Jan 1965, Italy.

The alloy consists of: (a) 0.1 to 0.4% by weight of Mo; (b) and either Nb or Zr, Nb when present amounting to 0.06 to 0.8% by weight, Mo then being equal to less than 0.3% by weight, Zr when present amounting to 1.5 to 2.2% by weight, Mo then being equal or greater than 0.2% by weight; (c) the balance of the alloy consists of U with usual impurities and has a fine grain structure after casting. (F.S.A.)

36885 MAGNESIUM–ZIRCONIUM ALLOYS. (to Messier). British Patent 1,197,652. 8 Jul 1970. Priority date 5 Jul 1967, France.

A method of preparing Mg–Zr alloys is described in which the Zr is introduced into a melt in the form of a Zr–Mg mother alloy in a flux containing at least 60% by weight of one or more potassium salts. Preferably the flux contains KCl or KF. The potassium halide salts serve to impart satisfactory melting points and at the same time impart greatly improved hot-state properties while limiting contamination. (J.R.D.)

36886 THERMODYNAMICS OF FORMATION OF Th–Ni ALLOYS. Skelton, W. H.; Magnani, N. J.; Smith, J. F. (Iowa State Univ., Ames). Met. Trans.; 1: 1833–7(Jul 1970).

Electromotive force cells have been used to determine the Gibbs free energies, entropies, and enthalpies of phase formation for Th_2Ni_{17}, $ThNi_5$, $ThNi_2$, ThNi, and Th_7Ni_3. Solid CaF_2 was employed as the electrolyte, and it has previously been shown that CaF_2 is an ionic conductor over the temperature range of measurements, 841 to 1141°K. The experimental results can be correlated with the atomic coordinations in the crystal structures of these five Th-Ni intermediate phases. (auth)

36887 KINETICS OF THE VAPOR PHASE CHLORINATION OF NIOBIUM OXYCHLORIDE BY PHOSGENE. Boesiger, D. D. (Phillips Petroleum Co., Bartlesville, Okla); Stevenson, F. D. Met. Trans.; 1: 1859–61(Jul 1970).

The kinetics of the homogeneous gas phase reaction between niobium oxychloride and phosgene was studied between 380 and 450°C in a constant volume reactor. The reaction was found to be essentially irreversible with the only detected reaction products being niobium pentachloride and carbon dioxide. The data obtained were fit by an elementary second-order rate equation. Values of the Arrhenius frequency factor and activation energy were found to be 1.33×10^6 liter/g mole/sec and 21.9 kcal/g mole with standard deviations of 0.05×10^6 and 1.4, respectively. (auth)

36888 SPUTTERING OF TANTALUM METAL ONTO TEFLON. Goldstein, R. M.; Bellina, J. J. Jr. (McDonnell Douglas Corp., St. Louis). Rev. Sci. Instrum.; 41: 1110(Jul 1970).

A technique to deposit adherent tantalum films onto Teflon disks up to 5.1 cm in diameter by a modification of the dc sputtering diode geometry is described. (W.H.K.)

36889 ETCHING METHOD FOR AUSTENITIC GRAINS. Rusu, B.; Riza, M.; Bende, B. (Hunedoara Metallurgical Works, Romania). Metalurgia (Bucharest); 22: 11–13(Jan 1970).

Heat-treatment and hot-working of steels require knowledge of the size of the austenitic grains. As the austenite is stable only above 800° these grains may be seen only by means of a high-temperature microscope. A method based on intercrystalline, high-temperature corrosion with oxygen was developed to render visible the austenitic grains on the polished surface of a metallographic specimen. The method involves immersion of the polished specimens into a molten silicate bath; the thermal shock resulting from cooling breaks the adhering molten layer, revealing the austenitic grain boundaries. The method indicates clearly the grain growth and transformations which occur in the steel; its results are comparable to those obtained by electrolytic etching. (JPRS)

36890 METHOD FOR PREPARATION OF THIN LAYERS OF MATERIAL. Winkler, Gerhard. Oesterr. Akad. Wiss., Math.-Naturwiss. Kl., Sitzungsber., Abt. II; 177: 331–41(1969). (In German).

To measure the characteristic x radiation, K radiation, a method for production of thin layers of the test substance on Mylar foils was developed. The finely pulverized test substance was suspended in a suitable fluid and, by sedimentation, was allowed to settle on the Mylar foil. Thicknesses from a few mg/cm² to several 10 mg/cm² were obtained. The technique proved valuable for determining K radiation in Ce, Dy, Er, Tm, Yb, Hg, Pb, and Hf. (H.B.G.)

Properties Evaluations

Refer also to abstracts 36470 and 37550.

36891 (AI-AEC-12955) SOLUBILITY STUDIES OF Cr, Co, Mn, Mo, Ni, Nb, Ti, V, AND Zr IN LIQUID SODIUM. Eichelberger, R. L.; McKisson, R. L. (Atomics International, Canoga Park, Calif.). 25 May 1970. Contract AT(04-3)-701. 30p. Dep. CFSTI.

Solubility experiments with solid refractory metals and iron group metals in liquid sodium were conducted at 600 to 1000°C. All materials used were the highest purity available, and procedures stressed the prevention of contamination from the environment. Equations were derived for four solutes as follows: $\log_{10}S$(wppM Cr in Na) = 5.876 – 5362/T(°K), $S_{700°C}$ = 2.3 wppM; $\log_{10}S$(wppM Ni in Na) = 1.594 – 1087/T(°K), $S_{700°C}$ = 3 wppM; $\log_{10}S$(wppM Nb in Na) = 2.20 – 654/T(°K), $S_{700°C}$ = 34 wppM; and $\log_{10}S$(wppM Zr in Na) = 5.429 – 3464/T(°K), $S_{700°C}$ = 74 wppM. Limitations in analytical methods, and experimental scatter precluded the derivation of similar equations for the other five solutes investigated. In the temperature range studied, the concentration of these metals in sodium was: Co <5, Mn <5, Mo <2, Ti 10 ± 5, and V <2 wppM. (auth)

36892 (GEAP-10135) LOW-CYCLE FATIGUE OF PROTOTYPE PIPING. Kiss, E.; Heald, J. D.; Hale, D. A. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Jan 1970. Contract AT(04-3)-189. 100p. Dep. CFSTI.

Details of testing, data, and analysis of prototype piping and components subjected to low-cycle fatigue are presented. The specimens were fabricated from materials used for the primary piping of pressurized water and boiling water nuclear reactor systems. Data have been obtained for cycles to crack initiation, through-wall and circumferential crack growth at room temperature and 550°F. Comparisons are made of fatigue data obtained from the prototype piping and laboratory tests of flat plates and round bars of similar materials. In addition, predictions of fatigue life are made according to the procedures of the ASME Nuclear Power Piping Code (B31.7) and compared with prototype test results. Data are included which show that piping components at BWR operating pressure, subjected to continued low-cycle fatigue loading, are almost certain to leak rather than fracture suddenly. (auth)

36893 (ORNL-4520, pp 84) EFFECT OF POWER CYCLING ON LMFBR FUEL-CLADDING BEHAVIOR. (Oak Ridge National Lab., Tenn.).

From Fuels and materials development program quarterly progress report for period ending December 31, 1969.

A series of reactor experiments are being designed for studying the effects of power cycling and power transients on the behavior of oxide fuel and the interactions of fuel and cladding. The calculations necessary to establish the geometry of the capsules were made so that a preliminary design and cost estimate may be made for the first experiment. (auth)

36894 (ORNL-4520, pp 202–10) CLADDING MATERIALS FOR SPACE ISOTOPIC HEAT SOURCES. (Oak Ridge National Lab., Tenn.).

From Fuels and materials development program quarterly progress report for period ending December 31, 1969.

The time and temperature parameters of embrittling-aging reactions in the superalloys Hastelloy N, Haynes alloy No. 25, and Haynes developmental alloy No. 188 were determined by impact testing of specimens aged at 650 to 900°C for times to 5000 hr. Hastelloy N was embrittled least. The results of a study of the evaporative losses of elements with high vapor pressures (i.e., Cr and Mn) from these alloys at 800 to 1050°C in 10^{-9} torr vacuum were also evaluated. These losses resulted in microstructural damage such as the formation of voids and solutioning of precipitates as well as changes in the morphology of the surfaces. In an effort to develop alloys that are strong and resistant to oxidation for containing radioisotopes in advanced thermoelectric generators for space applications, alloys that contain Pt are being investigated. The formation of long-range order in the alloy Pt_3Cr (alloy S-19) results in an exceptionally low primary creep rate and also reduces the steady-state creep rate, indicating the su-

perior properties of such structures. The lower stress exponent of 3 that characterizes the ordered alloys (versus 5 for unordered alloys) is also a desirable feature in applications that require resistance to high applied stress. Comparisons of the time to produce 1% strain in vacuum at 900°C and a stress of 10,000 psi showed alloy S-19 to be superior to Haynes alloy No. 25. At about 1000°C, the evaporative resistance is also vastly superior to that of Haynes alloy No. 25, and the oxidation resistance is greatly superior to that of the refractory alloys. (auth)

36895 (ORNL-4520, pp 227-44) TUNGSTEN METALLURGY. (Oak Ridge National Lab., Tenn.).

From Fuels and materials development program quarterly progress report for period ending December 31, 1969.

It was determined that the creep rate of W at 1800°C increases significantly with increasing O_2 pressure between 1.1×10^{-7} and 1.9×10^{-5} torr primarily due to the sublimation of volatile oxides. Long-time creep data on arc-melted W-Re alloys and chemically vapor deposited W are presented and compared for primary and secondary design criteria for nuclear applications. Additional tests on powder-metallurgy W-25% Re confirmed that at 500 psi this material has a lower creep rate at 2200°C than at 1650°C. Electron fractography on creep specimens of powder-metallurgy W at low strains showed that grain-boundary cracks grow by the merger of small voids. The optimum welding conditions for gas W-arc welding of W-25% Re sheet with and without Mo-50% Re filler metal is being determined. Continued efforts to eliminate nodules completely from chemically vapor deposited W-5% Re by interrupted deposition were not successful. (auth)

36896 (ORNL-4520, pp 315-26) IMPROVEMENT OF HASTELLOY N AND RELATED COMPOSITIONS. (Oak Ridge National Lab., Tenn.).

From Fuels and materials development program quarterly progress report for period ending December 31, 1969.

The concentrations of Nb, Ti, Zr, and Hf in modified Hastelloy N were optimized to give good mechanical properties after irradiation. Small heats of alloys containing up to 2% of each element were prepared for study. Aging studies at 650 and 760°C showed that the tensile and yield strengths were reduced and that the fracture strains ranged from 19 to 45%. These property changes in the absence of irradiation are not thought to be serious. Some of these modified alloys were irradiated, and those alloys that contained finely dispersed carbides of the MC type had good post-irradiation properties. Scale-up studies on 50-lb heats revealed some porosity in welds in an alloy that contained 1% Ti and 1% Hf and some cracking of the weld metal in an alloy that contained 0.5% Hf and 2% Nb. Surveillance samples from the Molten Salt Reactor Experiment (MSRE) have made it possible to study the changes that occur in the mechanical properties of standard Hastelloy N as a result of irradiation. The fracture strain reaches a minimum at a strain rate of about 0.1%/hr. Thermal irradiations that produce only 1 ppM He in the alloy reduce the fracture strain from 30% to about 2%. Further irradiation results in fracture strains as low as 0.5% when the He concentration reaches 40 ppM. (auth)

36897 (ORNL-tr-2325) DEVELOPMENT OF TERNARY URANIUM ALLOYS WITH A LOW ALLOYING CONTENT (U-Nb-Cr, U-Nb-Fe, U-Nb-Ni, U-Nb-Si, U-Nb-Zr). Bastelli, M. R.; D'Amato, C.; Renzoni, R.; Saraceno, F. S.; Wilson, T. B. Translated for Oak Ridge National Lab., Tenn., from report EUR-4384. 66p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 24: 12393.

36898 (RFP-1457) ADSORPTION ON PLUTONIUM. PART II. THE LIGHT-WEIGHT HYDROCARBONS. Musgrave, Larry E.; DiGiallonardo, Anthony (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). 25 May 1970. Contract AT(29-1)-1106. 9p. Dep. CFSTI.

The sticking probability and surface coverage of methane, ethylene, and ethane molecules impinging on evaporated plutonium films were measured. The sticking probability showed a rapid decrease from 0.2 to a nearly constant value of 0.01, until full coverage, when a rather rapid decrease occurred. The coverage varied from 14.5×10^{14} molecules per square centimeter for methane, 8.8×10^{14} molecules per square centimeter for ethylene, and 11.0×10^{14} molecules per square centimeter for ethane. Possible bonding mechanisms are discussed. (auth)

36899 (WARD-4135-9) STAINLESS STEEL CLADDING DEVELOPMENT. Quarterly Progress Report for Period Ending March 31, 1970. Ray, W. E. (Westinghouse Electric Corp., Madison, Pa. Advanced Reactors Div.). Apr 1970. Contract AT(30-1)-4135. 31p. Dep. CFSTI.

Microcharacterization and mechanical property testing, including biaxial tensile, biaxial stress rupture, and both uniaxial and biaxial creep were continued on WARD vaccum melted austenitic materials. Preliminary metallographic characterization of double vacuum melted Type 316 tubing, stainless steel fabricated by planetary swaging, has been completed for both 20 percent cold worked and solution annealed conditions. Comprehensive structure characterization of the planetary swaged materials, including transmission and scanning electron microscopy, electron and x-ray diffraction, and texture analysis by pole figures is almost completed. Post test stress rupture specimens have been classified according to rupture type and microstructural evaluation of selected specimens initiated. Biaxial stress rupture data scatter was evaluated, and a temperature correction procedure was proposed for the minor temperature variation (± 15°F) inherent in the test. Additional low cycle, high strain fatigue tests have been conducted. The new specimen design, testing procedure, and results from the current tests have been evaluated. An additional partial shipment of 250 feet of 20 percent cold worked Battelle-Northwest double vacuum melted Type 316 stainless steel tubing has been received for use in the Oxide Fuel Element Development Program, bringing the total to 500 feet received to date. A shipment of 103 feet of solution annealed WARD double vacuum melted Type 316 stainless steel tubing, manufactured by planetary swaging, has been received for use in the characterization studies. Mechanical property testing and structural characterization have been initiated. (auth)

36900 (ZJE-74) CZECHOSLOVAK STEELS FOR REACTOR PRESSURE VESSELS. Indra, J. (Skoda Concern, Pilsen (Czechoslovakia). Nuclear Power Plants Div.). 1970. 25p. Dep. CFSTI (U. S. Sales Only).

Parameters associated with the increase of the size of reactor steel pressure vessels are analyzed. Steel materials and the measures taken such as alloying, heat treatment, and accelerated cooling to increase their strength are described. Radiation effects, fatigue, and the size factor of pressure vessels are dealt with. chemical composition and mechanical properties of some steels are also presented. (auth)

36901 MIKROTVERDOST' METALLOV I POLUPROVODNIKOV. Izdanie Vtoroe, Ispravlennoe i Dopolnennoe. (Microhardness of Metals and Semiconductors. Second Edition, Corrected and Supplemented). Glazov, V. M.; Vigdorovich, V. N. Moscow; Izdatel'stvo Metallurgiya (1969). 248p.

Microhardness data and phase diagrams are given for various materials including Al, Cu, Ge, Hf, In, Mo, Nb, Ta, Ti, W, V, Zr, carbides, and other metals and alloys. (375 references) (R.V.J.)

36902 BENDING OF PERFORATED PLATES WITH SQUARE PENETRATION PATTERNS. LeFort, P. (General Electric Co., San Jose, Calif.). Nucl. Eng. Design; 12: 122-34(May 1970).

The application of the field equations governing the bending of plates, with shear deformation present, to the study of perforated plates is presented. Results are included on the effective elastic constants in bending for a wide range of ligament efficiencies and depth to pitch ratios. The point-matching or collocation method was used to determine the solution coefficients with numerical calculations carried out on a GE 635 computer. (auth)

36903 COMPARISON BETWEEN THE RESULTS OBTAINED BY HARDNESS AND RESISTIVITY MEASUREMENTS ON THE RECOVERY AND RECRYSTALLIZATION OF PURE ZIRCONIUM. Billion, Marc; Renucci, Louis; Langeron, Jean-Paul (CNRS, Vitry, France). Compt. Rend., Ser. C; 270: 895-6(2 Mar 1970). (In French).

The concomitant variation of the resistivity and hardness of zirconium can be explained on the elimination of dislocations after annealing at temperatures higher than 150°C. The apparent difference between the recovery rates of these two properties is due to the proportion which the resistivity bears to the dislocation density and to the proportion which the hardness bears to the square root of this last quantity. (auth)

36904 RELATIVE INFLUENCE OF GASEOUS AND METALLIC IMPURITIES ON THE ELECTRICAL RESISTANCE OF MOLTEN LITHIUM. Arnol'dov, M. N.; Ivanovskii, M. N.; Pleshivtsev, A. D.; Subbotin, V. I.; Shmatko, B. A. This paper was summarized in At. Energ. (USSR); 27: 332-3(Oct 1969) as paper No. 343/5189. (In Russian).

The presence of gaseous oxygen, hydrogen, nitrogen and carbon impurities in molten-metal coolants is reflected in many of the physical properties of the metal. The measured addition of specific gaseous impurities to the metal permitted the study of the impurity electrical resistance in systems of Li-O-C, Li-O-N, Li-O-H, Li-N-H, Li-O-C-N-H, and Li-Na-N, and Li-Na-H, containing an excess amount of lithium, at 300°C. The system Li-O-C was studied by introducing gaseous carbon dioxide into the molten lithium. Air was used in the Li-O-N system, and water was used

in the Li–O–H system. In the remaining systems the impurities were introduced separately. In all cases the additional impurity electrical resistance was an additive function of the concentration of impurities, which were primarily nitrogen and hydrogen. This indicated an absence of significant interparticle interaction of the gaseous impurities in the melt and agreed with thermodynamic calculations. The addition of sodium impurities led to a reduction in the fraction of the impurity resistance in lithium which was due to nitrogen. At a sodium concentration of 3% by weight the additional electrical resistance in the lithium due to the nitrogen practically disappears. There appeared to be a significant interparticle interaction in the lithium–nitrogen–sodium system. The nature of the observed interaction was not clear. In the lithium–hydrogen–sodium system the same type of effect of the sodium on the impurity resistance of hydrogen in lithium was observed. As with the nitrogen, the impurity electrical resistance of the hydrogen nearly disappeared at a sodium concentration of 0.3% by weight. (auth)

36905 INDUSTRIAL USES OF DEPLETED URANIUM. Nucleus (Paris); 10: 214-16(1969). (In French).

Depleted uranium with a density 1.7 times that of lead and with a cost much less than that of tungsten of equivalent density can be used as biological protection against γ and x radiation, containers for the transport and storage of radioactive materials, collimators for irradiators, inertia mass for aeronautics, and vibration absorption by inertia. The characteristics of depleted uranium are outlined. Some actual uses of depleted uranium as containers, material in gammagraphy, and inertia masses are described. (J.S.R.)

36906 HEAT CAPACITY OF TUNGSTEN NEAR MELTING POINT. Dikhter, I. Ya.; Lebedev, S. V. (Inst. of High Temperatures, Moscow). Teplofiz. Vys. Temp.; 8: 55-8(Jan-Feb 1970). (In Russian).

The measurements of heat capacity were made during the heating of tungsten wire at 2600 to 4500°K at high voltage. The temperature was recorded by the photoelectric method using oscillograms of luminescence. The specific heat was also measured. (tr-auth)

36907 MECHANICAL PROPERTIES OF Ti–Al–Mo ALLOYS DURING HEAT TREATMENT. Khorev, A. I.; Chinenov, A. M.; Martynova, M. M. Metalloved. Term. Obrab. Metal.; No. 12, 67-9(1969). (In Russian).

The effects of composition and heat treatment on the mechanical properties of titanium alloys containing 3% Al and from 0.5 to 30% Mo were studied. The effects molybdenum additions on titanium alloys containing aluminum after various heat treatments were also studied. Sensitivity to superheat was increased with increased molybdenum additions. (tr-auth)

36908 ELECTRIC PROPERTIES OF β-RHOMBOHEDRAL BORON AT HIGH TEMPERATURES. Golikova, O. A.; Kiskachi, A. Yu.; Khomidov, T. (Leningrad Inst. of Semiconductors). Fiz. Tekh. Poluprov.; 4: 804-8(Apr 1970). (In Russian).

Electric properties of spectrally pure, large-grain, monocrystalline boron of the β-rhombohedral modification were studied. The electric conductivity, thermal emf at 550 to 2200°K, and the Hall coefficient at 450 to 1250°K were measured. (R.V.J.)

36909 ELECTROMOTIVE FORCE STUDIES OF LIQUID URANIUM–ZINC ALLOYS. Hoshino, Y.; Plambeck, J. A. (Univ. of Alberta, Edmonton). Can. J. Chem.; 47: 965-9(15 Mar 1969).

The electromotive force of cells of the type U(s)/LiCl–KCl (eutectic) + UCl_3/(U + Zn) (liquid alloy) were measured over the temperature range 450 to 550°C, in the zinc-rich region of alloy composition. Thermodynamic functions for the limiting uranium-zinc intermetallic compound existing in this region are: ΔG^0_f, –23.0 kcal/mole; ΔS^0_f, –37.1 cal/deg mole; ΔH^0_f, –62.9 kcal/mole at 535°C. These values are compared with those previously reported by other workers. (auth) (Canada)

36910 ROLLING OF NIOBIUM ALLOYS IN VACUUM. Gurevich, Ya. B.; Pavlov, I. M.; Krupin, A. V.; Orzhekhovskii, V. L.; Chernyshev, V. N.; Anikeev, N. A. (Moscow Inst. of Steel and Alloys). Izv. Vyssh. Ucheb. Zaved., Tsvet. Met.; No. 6, 121-5 (1969). (In Russian).

Niobium alloys rolled in a vacuum showed resistance to recrystallization and retained uniform deformation. These alloys were deformed adequately at room temperature or during superheating at 400°C. Nb–Ti–Mo alloys rolled in vacuum at room and higher temperatures showed higher strength and ductility than rolling in air. Increased strength was observed in Nb–Ti–V and Nb–Ti–Al alloys. (tr-auth)

36911 SPECIAL WELDING MATERIALS IN REACTOR CONSTRUCTION. Lechtenboehmer, H. (UTP-Schweissmaterial Gesellschaft mbH and Co.; Freiburg i. B.). Atomwirt., Atomtech.; 15: 233-4(May 1970). (In German).

Reactor construction frequently requires special electrodes and special types of welding wire. A particular set of electrodes and wires is described that is based on nickel, chromium, manganese, iron, niobium, and titanium. The technique permits solution of the most difficult welding problems encountered in reactor construction. Two practical examples are given. Thermal and mechanical properties of the welding material are presented in three tables. (H.B.G.)

36912 PROGRAMMED TEST METHOD OF HEAVY THICKNESS STEEL PLATES FOR NUCLEAR VESSELS. Susukida, Hiroshi; Ando, Tomozumi; Hibaru, Y. (Mitsubishi Heavy Industries, Ltd., Kobe, Japan). Mitsubishi Juko Giho; 7: 132-7 (Mar 1970). (In Japanese).

A programmed test method has been developed which is capable of verifying the mechanical properties of heavy thickness steel plates for nuclear vessels by using small specimens which are simulated to the cooling curves from austenitized temperature of vessel segments by a specially designed heating and cooling apparatus. Hopefully, this test method can be applied to actual production in place of the conventional vessel test method or the 3 T test method which requires a large quantity of testing materials. (NSA of Japan)

36913 BONDED BAR AND SLEEVE REINFORCED PENETRATIONS IN CONCRETE SLABS. O'Connell, J. M. (Central Electricity Generating Board, Berkeley, Eng.). J. Brit. Nucl. Energy Soc.; 9: 113-19(Apr 1970).

Gas-cooled reactors of the current series contain a number of large circular penetrations set in the walls of prestressed concrete pressure vessels. Methods of reinforcing these penetrations vary; in some instances a steel sleeve is used, in others bonded bars are preferred. However, little was known concerning the influence of bonded steel reinforcement on the stresses and deformations in the vicinity of penetrations. Information is provided relating to stresses and deformations at penetrations which are reinforced with a steel sleeve or bonded steel rings. (auth) (UK)

36914 DEFORMATION BEHAVIOR OF CONTINUOUS-FIBER METAL-MATRIX COMPOSITE MATERIALS. Cheskis, H. P.; Heckel, R. W. (Drexel Univ., Philadelphia). Met. Trans.; 1: 1931-42(Jul 1970).

The deformation behavior of continuous-fiber, metal-matrix composites was studied in terms of in situ deformation behavior of the matrix and the fibers. X-ray diffraction techniques were employed to monitor the stress-strain behavior of the composite components (matrix and fibers) as a function of total composite stress-strain behavior. This experimental technique provided a unique approach to the study of metal-matrix composites since the deformation response of the components could be measured in situ while the composite was under load. Furthermore, the influence of residual stress, component mechanical properties, and stress interactions between the matrix and the fibers could be incorporated into the analysis of composite deformation behavior. The study was conducted on composites of 2024 aluminum reinforced with tungsten fibers, and composites of 2024 aluminum reinforced with boron fibers. Composites were tested on a specially designed, tensile device which served as a diffractometer specimen holder such that diffraction experiments could be performed while the specimen was incrementally deformed in uniaxial tension. Experimental results indicated that, except for the residual stress effects, the composites exhibited rule-of-mixtures behavior in the stage I, II, and III deformation regions. Measurements obtained perpendicular to the fiber and tensile axis during the tensile tests indicated that negligible stresses were developed as a result of Poisson's ratio differences between the matrix and the fibers. Composite yield behavior was significantly influenced by residual stresses present in the individual components. Residual stresses parallel to the fiber axis could be included in the rule-of-mixtures analysis by considering the amount of prestrain which was present in each component. (auth)

36915 DIFFUSION OF NITROGEN IN Mo AND W. Jehn, H.; Fromm, E. (Max-Planck-Institut fuer Metallforschung, Stuttgart). J. Less-Common Metals; 21: 333-6(Jul 1970). (In German).

A review of information on diffusion of N in Mo and W is presented. Data are included on degassing rate for Mo wire as a function of temperature, diffusion coefficients for N in Mo and W at 1200 to 2200°C and diffusion rates as a function of energy in kcal/mol. (J.R.D.)

36916 EFFECT OF HIGH PRESSURES ON THE ELECTRICAL CONDUCTIVITY OF PRASEODYMIUM AND SOME PRASEODYMIUM ALLOYS. King, E. (United Kingdom Atomic Energy Authority, Harwell, Eng.); Harris, I. R. J. Less-Common Metals; 21: 275-82(Jul 1970).

High-pressure resistivity studies on praseodymium have shown

that there is a maximum in the resistance at a pressure of about 40 kb. A study has been made of the effect on this resistance maximum of alloying additions of the trivalent rare-earth elements gadolinium, terbium, holmium and yttrium, and the tetravalent actinide metal thorium, all of which form solid solutions in double-hexagonal praseodymium. It is found that the hexagonal-close-packed rare-earth metals increase the pressure at which the resistance maximum occurs, whereas face-centred-cubic thorium lowers the pressure of the resistance maximum. (auth)

36917 ISOTOPE EFFECT IN ELECTRON-STIMULATED DESORPTION: OXYGEN CHEMISORBED ON TUNGSTEN. Madey, Theodore E.; Yates, John T. Jr.; King, David A.; Uhlaner, Carole J. (National Bureau of Standards, Washington, D. C.). J. Chem. Phys.; 52: 5215-20(15 May 1970).

Electron stimulated desorption (ESD) studies of oxygen chemisorbed on tungsten revealed a large isotope effect in the desorption of ions. The probability of desorption of $^{16}O^+$ was found to be a factor of ~1.5 greater than the probability of desorption of $^{18}O^+$ upon bombardment of the adsorbed layer by 100-eV electrons. This observation is quantitatively consistent with the ESD mechanism proposed independently by Redhead and by Menzel and Gomer. On the other hand, the small isotope effect observed in ESD total desorption does not agree with this mechanism; possible reasons for this are discussed. (auth)

36918 INFLUENCE OF COLD WORKING BY COLD PILGER ROLLING ON THE PROPERTIES OF ZIRCALOY TUBES. Richter, Herbert; Schelzke, Erhard (Vereinigte Deutsche Metallwerke AG, Duisburg, Ger. Metallgesellschaft AG, Frankfurt am Main). Z. Metallk.; 61: 415-20(Jun 1970). (In German).

The properties of Zircaloy tubes as a cladding material for the uranium oxide fuel in nuclear power stations were decisively influenced by their state of cold work. The mechanical properties and the orientation of the zirconium hydride precipitates formed during operation of the reactor can only be adjusted to the requirements of reactor construction, if with cold working by pilger rolling the appropriate tube texture is produced by presetting the Q-value, and if through cold working and heat treatment the optimum state of strength is achieved. (auth)

36919 SPECIFIC HEATS OF PLUTONIUM AND NEPTUNIUM. Lee, J. A. (Atomic Energy Research Establishment, Harwell, Eng.) Mendelssohn, K.; Sutcliffe, P. W. Proc. Roy. Soc. (London), Ser. A; 317: 303-17(23 Jun 1970).

The specific heats of plutonium and neptunium metal have been measured from 13 and 7.5 K respectively, to 300 K. Both metals have very high electronic specific heats of 15.9 and 14.2 mJ $mole^{-1}$ K^{-2}. A small anomaly in plutonium at about 60 K was found and is possibly caused by magnetic ordering. The specific heat of neptunium is a smooth function over the whole temperature range. (auth) (UK)

36920 PLATINUM METALS FROM NUCLEAR FISSION, AN EVALUATION OF THEIR POSSIBLE USE BY INDUSTRY. Newman, R. J.; Smith, F. J. Platinum Metals Rev.: 14: 88-92(Jul 1970).

Metals of the platinum group are being produced in appreciable and growing quantities as by-products of nuclear fission in atomic reactors. It has been suggested that rhodium, palladium, and ruthenium might possibly be separated in the reprocessing of spent fuel and be used in industry but from calculations recently made it is now shown that their levels of radioactivity would be unacceptably high and their use would entail a risk of contamination of world stocks of all the platinum metals. The growth of mining operations is expected to provide ample supplies of all the platinum group metals and there is no prospect of exhausting mineral resources in the foreseeable future. (auth) (UK)

Structure and Phase Studies

36921 (CEA-CONF-1513) POINT DEFECTS STUDIES IN NIOBIUM. Pichon, R.; Vanoni, F.; Bichon, P.; De Keating-Hart, G.; Moser, P. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). 1969. 36p. (In French). (CONF-691046-1). Dep. CFSTI (U. S. Sales Only).

From Meeting on Niobium, Paris, France.

High purity niobium was produced by the zone melting technique and then annealed in ultrahigh vacuum. The purity was monitored by resistivity measurements at 4°K and by activation analysis. Electron irradiation studies were then made on the niobium at very low temperatures. Measurements of the resistivity recovery were carried out with the object of determining a model which describes the process of annihilation and agglomeration of the radiation induced defects. The hypothesis of an intrinsic interstitial migrating at low temperature is found to be verified through comparative study with other bcc metals (Fe and Mo). The hypothesis of a second type of intrinsic interstitial mobile at room temperatures is not verified. The study of the interaction of the intrinsic defects with the impurity was made using a model involving modification of the defect clustering and annihilation processes, and a model involving trapping of the impurity by the defects. (auth) (France)

36922 (ORNL-4520, pp 211-26) PHYSICAL AND MECHANICAL METALLURGY OF REFRACTORY ALLOYS. (Oak Ridge National Lab., Tenn.).

From Fuels and materials development program quarterly progress report for period ending December 31, 1969.

Potential problems associated with use of refractory alloys in advanced isotopic heat sources were defined including interaction of liners with oxide fuels, contamination of refractory alloys with degassed interstitials, plugging of nonselective vents with decomposed gases, and hydriding of Nb and Ta alloys after reentry into water. An apparatus for creep testing Ta alloys in low-pressure N_2 is being installed to simulate the interaction of Ta alloys with the N of nitride fuels. The aging characteristics of equimolar Ta–Hf alloys were determined. These studies suggest a simple β, $(\beta + \alpha)$, α sequence of phases with increasing Hf rather than a miscibility gap. Several quasichemical models for spinoidal decomposition were applied to real solutions. A model based on clustering and nonrandom configurational entropy qualitatively predicts the experimental observations. The electrical resistivity and absolute Seebeck coefficient of Nb–10% W to 1700°K were determined. A direct heating apparatus for measuring these properties and thermal conductivity is being evaluated. Stress-rupture properties of electron-beam welds of TZM and W–25% Re at 1400, 1650, and 2000°C were determined. The remelt temperature of Ti–48% Zr–4% Be braze alloy on Ta was 75°C below its original melting temperature, and that for the Ti–46% Zr–8% Ge alloy was higher by 20 to 40°C. Six techniques for producing leak-tight joints of Pt and Ta–10% W were investigated. A three-tube joint with a W transition layer was leak-tight after 500 hr at 1200°C but not after 1000 hr. (auth)

36923 (RT/MET-(70)2) PROCESSES OF TRANSFORMATION IN ALLOYS OF URANIUM CONTAINING 2 PERCENT MOLYBDENUM AND 2 PERCENT NIOBIUM. Castaldelli, L.; Fizzotti, C.; Gandini, A. G. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). [1969]. 40p. (In Italian). Dep. CFSTI (U. S. Sales Only).

TTT curves of two uranium alloys containing 2 wt % molybdenum and 2 wt % niobium are shown and discussed together with the different transformations occurring in these alloys at particular temperatures. (auth)

36924 ELECTRON-PROBE MICROANALYSIS. THE USE OF ELECTRON-PROBE MICROANALYSIS FOR INCLUSION IDENTIFICATION AND THE EVALUATION OF SEGREGATION. Ranzetta, G. V. T. (West Australian Inst. of Tech., Perth). Metals Aust.; 1: 307-11(Dec-Jan 1969-70).

A description of the technique of electron probe microanalysis is given and its use in the identification of dispersions and segregates in metals is discussed. Examples of determinations of inclusions in metals are illustrated. (Australia)

36925 INFLUENCE OF CRYSTALLINE DEFECTS ON 2-BEAM CRYSTAL LATTICE IMAGES: EXPERIMENTAL. Parsons, J. R.; Rainville, M.; Hoelke, C. W. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Phil. Mag.; 21: 1105-17(Jun 1970).

Of particular interest in the study of crystal lattice imperfections are the magnitude and extent of their influence on atomic structure. In the present work two-beam crystal lattice images have been used to examine directly the perturbing influence of Guinier–Preston zones in Al 4% Cu, damaged regions in neutron irradiated Ge, and dislocations in deformed and partially crystallized Ge. The 2.02 Å spacing of (200) planes was resolved in Al-4% Cu while the 3.26 Å spacing of (111) planes was resolved in the Ge specimens. The crystal lattice images were obtained using a high vacuum, short focal length (2.1 mm) Siemen's Elmiskop 1 operated at 100 kV with pointed filaments and thin film objective apertures. The experimental observations reveal: that the G.P. [1] zones are coherent with the matrix (200) planes and produce an observable tensile distortion out to ~20 Å on either side of its centre; that when a damaged region in Ge has a size equal to the foil thickness, then the lattice image disappears over the small region occupied by the damaged region; that a 60° edge dislocation in Ge produces an apparent asymmetry in the displacement of (111) planes; and that the resolved (111) planes in Ge have a pronounced s-shape as they cross an inclined screw dislocation. (auth) (UK)

36926 CONCERNING THE EXISTENCE OF NbTi IN SYSTEM Nb–Ti. Zakharov, A. M.; Pshokin, V. P.; Baikov, A. I. (Moscow Inst. of Steel and Alloys). Izv. Vyssh. Ucheb. Zaved., Tsvet. Met.; No. 6, 104-8(1969). (In Russian).

The phase diagram of the Nb–Ti system was constructed in the range of the concentration of 0 to 57.6 weight percent Ti by microscopic and x-ray phase analyses. The melting point and the mechanical and physical properties of the alloys annealed at various temperatures were studied. The analyses showed that niobium with β-titanium forms a continuous series of solid solutions with bcc latices. An alloy containing 35% Ti and 0.8 to 2.0% C was also revealed. (tr-auth)

36927 NICKEL-RICH PORTION OF THE Ni–Al–Nb PHASE DIAGRAM. Cisse, J.; Davies, R. G. (Ford Motor Co., Dearborn, Mich.). Met. Trans.; 1: 2003-6(Jul 1970).

The solubility of Nb + Al in the γ solid solution decreases markedly with decreasing temperature; thus alloys can be prepared that are γ at 1200°C and yet contain 50% γ' precipitate after aging at 800°C. Thermal stability of the γ' precipitate is related to the lattice mismatch between the γ and γ' phases; the smaller the mismatch the lower is the interfacial elastic energy and the more stable is the γ'. Upon aging certain alloys at 800°C a γ' growth interface other than the normal $(100)_\gamma \| (100)_{\gamma'}$ is observed. The maximum solubility of the niobium in γ' is ~7 at. %; the width of the γ' field increases with increasing niobium content but it is essentially independent of temperature. Replacing aluminum by niobium in γ' gives hardnesses of up to 400 dpn. (auth)

36928 EFFECT OF CARBIDE AND NITRIDE ADDITIONS ON THE HETEROGENEOUS NUCLEATION BEHAVIOR OF LIQUID IRON. Bramfitt, Bruce L. (Bethlehem Steel Corp., Pa.). Met. Trans.; 1: 1987-95(Jul 1970).

A systematic study of carbide and nitride additions on the heterogeneous nucleation behavior of supercooled liquid iron was undertaken. It was found that titanium nitride and titanium carbide were very effective in promoting heterogeneous nucleation. These compounds were followed by silicon carbide, zirconium nitride, zirconium carbide, and tungsten carbide in decreasing order of effectiveness. The degree of potency of the nucleation catalysts is explained on the basis of the disregistry between the lattice parameters of the substrate and the nucleating phase. Through the inclusion of planar terms the Turnbull-Vonnegut "linear" disregistry equation was modified to more accurately describe the crystallographic relationship at the interface during heterogeneous nucleation. (auth)

36929 FACTORS INFLUENCING THE FORMATION OF SILVER-RICH SOLID SOLUTIONS IN RARE-EARTH–SILVER ALLOY SYSTEMS. Gschneidner, K. A. Jr.; McMasters, O. D.; Alexander, D. G.; Venteicher, R. F. (Iowa State Univ., Ames). Met. Trans.; 1: 1961-71(Jul 1970).

The solid solubilities of all of the naturally occurring rare-earth metals in silver have been determined by an x-ray parametric method. The solubilities range from 0.01 to 0.02 at. % for Eu to 10.5 at. % for Sc. The stoichiometries of the silver-rich compounds and some of their crystal structures were determined. The silver-rich compounds found in this study are: RAg_3(La, Ce, Pr, Eu, and Yb), RAg_4(Lu and Sc), $R_{14}Ag_{51}$(La to Sm, Gd to Er, Yb, and Y) and $TmAg_3$. The silver/silver-rich compound eutectic temperatures were also determined. Analysis of these data indicates that several factors in addition to the Hume-Rothery criteria influence the formation and extent of solid solutions. These include the mutual adjustment of size and electronegativity of the solvent and solute if the pure metal size differences are less than a critical value of 22 to 25%, the composition of the first solvent-rich compound, and the lattice rigidity of the solvent. (auth)

36930 OMEGA TRANSFORMATION IN Hf–Nb ALLOYS. Jackson, W. A.; Perkins, R. J.; Hehemann, R. F. (Case Western Reserve Univ., Cleveland). Met. Trans.; 1: 2014-16(Jul 1970).

Results of an electron micrographic investigation of a Hf–32% Nb alloy are presented. It was found that the ω transformation occurs in this alloy in a manner analogous to behavior of high solute content Zr-base and Ti-base alloys. This indicates that the ω transformation exists in all Hf-base alloys. (J.R.D.)

36931 KINETICS OF Ti_3Al GRAIN BOUNDARY PRECIPITATION IN Ti–Al BINARY AND Ti–Al–X TERNARY ALLOYS AND CORRELATION WITH MECHANICAL PROPERTIES. Crossley, F. A. (IIT Research Inst., Chicago). Met. Trans.; 1: 1921-9 (Jul 1970).

Grain boundary precipitation of Ti_3Al was found to proceed rapidly in Ti–Al, Ti–Al–O, and Ti–Al–Sn alloys. Additions of Zr, Nb, Mo, and V retarded the precipitation reaction and appeared to inhibit or suppress it at grain boundaries. The nose of the TTT curves for the precipitation reaction occurred at about 650°C. Although the precipitation reaction apparently starts at grain boundaries in less than 1 hr at the nose, the reaction is very sluggish within grains and was not completed in 129 hr at the temperature of the nose. Toughness is degraded and recovers in 500 hr at 650°C. The ternary additions, except tin, slow the degradation of toughness in apparent concert with their retardation of the kinetics of the Ti_3Al precipitation reaction. (auth)

36932 INTERDIFFUSION IN AND THE PHASE DIAGRAM FOR VANADIUM-RICH ALLOYS OF THE V–Al SYSTEM AT PRESSURES 0 TO 47 KBAR. Shinya'ev, A. Ya.; Butrymowicz, Daniel B. (National Bureau of Standards, Washington, D. C.). Met. Trans.; 1: 1905-7(Jul 1970).

The V–Al system between 16 and 39 at. % Al was studied at 1400°C under pressures of 0, 30, and 47 kbar. Electron microprobe analysis, x-ray diffraction, microhardness readings, and metallographic examination revealed only a single solid solution. Interdiffusion coefficients were determined as a function of composition and pressure. Concentration gradients were measured with an electron microprobe analyzer and the diffusion coefficients were calculated by the Matano analysis. At 1400°C, the value of the interdiffusion coefficient varied from 1 to 12×10^{-9} sq cm/sec increasing with aluminum content and decreasing with increasing pressure. (auth)

36933 AGEING IN NIOBIUM-RICH NIOBIUM–HAFNIUM–CARBON ALLOYS. Williams, A. J.; Briggs, D. C. (Dept. of Energy, Mines, and Resources, Ottawa). J. Less-Common Metals; 21: 255-73(Jul 1970).

Age-hardening of niobium alloys with up to 12 wt. % hafnium and 0.5 wt. % carbon has been investigated using hardness measurements, metallography, and x-ray diffraction analysis. A mild age-hardening has been found in alloys containing more than 2% hafnium and 0.25% carbon. This occurred after aging in the range 1100 to 1200°C and was related to the precipitation of the complex monocarbide, (Nb, Hf)C. Several factors that reduce or eliminate the hardening to be expected from (Nb, Hf)C precipitation have been identified and discussed. A ζ-carbide, resembling the ζ-tantalum carbide and the ϵ-niobium carbide found by other workers, has been found to form during quenching from temperatures above 1600°C. It is metastable at room temperature but is rapidly replaced by the equilibrium carbide at temperatures of 1200°C and above. (auth)

36934 SYSTEM TANTALUM–HYDROGEN: PHASE DIAGRAM AND ELECTRONIC STRUCTURE. Ducastelle, F.; Caudron, R.; Costa, P. (ONERA, Chatillon, France). J. Phys. Chem. Solids; 31: 1247-56(Jun 1970). (In French).

The study of the electronic specific heat and of the magnetic susceptibility of Ta–H compounds was carried out in order to check the validity of the rigid d band model, which has already been put forward for several transition metals hydrides. The behavior of these compounds was shown to be quite similar to the behavior of the isoelectronic alloys Ta–W. During this work, some precisions had to be brought on some obscure points of the binary diagram Ta–H through resistivity and x-ray diffraction experiments. In particular, the solubility limits of the Ta-rich solid solution and of the orthorhombic compound near $TaH_{0.5}$ were determined. (auth) (UK)

36935 X-RAY STUDY OF THE Zr–Nb–Ni SYSTEM. Evdokimova, A. D.; Kuznetsova, S. M.; Ronami, G. N.; Sokolovskaya, E. M. Vestn. Mosk. Univ., Ser. II, Khim.; 11: 62-6(Jan-Feb 1970). (In Russian).

Local x-ray spectral analysis of the ternary system of Zr–Nb–Ni was made using alloys previously treated at 800°C for 700 hr and at 500° for 2000 hr. Tabulated data of the analysis and a phase equilibrium diagram in the Zr–Nb–Ni system at 800° are in good agreement with the results obtained by other physicochemical methods. (R.V.J.)

36936 EUROPIUM AND DYSPROSIUM VALENCY STATES IN LAVES PHASES AND ISOMERIC SHIFTS IN MOESSBAUER SPECTRA. Efremov, E. N.; Babeshkin, A. M.; Nesmeyanov, An. N. Vestn. Mosk. Univ., Ser. II, Khim.; 11: 46-8(Jan-Feb 1970). (In Russian).

Isomeric shifts in the Moessbauer spectra for Eu and Dy intermetallic compounds belonging to the structural type of Laves phases were considered. The valence of Eu in these compounds was found to depend on occupation of the d-level in transition metals which were the second constituents of Laves phases. (auth)

Radiation Effects

Refer also to abstracts 36994 and 38512.

36937 (AI-AEC-12961) VOID FORMATION IN PROTON-IRRADIATED STAINLESS STEEL. Keefer, D. W.; Neely, H. H.; Robinson, J. C.; Pard, A. G.; Kramer, D. (Atomics International, Canoga Park, Calif.). 30 Jun 1970. Contract AT(04-3)-824. 23p. Dep. CFSTI.

Voids have been produced by 1.2-MeV proton irradiation at 500°C in Type 316 stainless steel containing 2 atomic parts per million (appM) helium. The proton fluence was 6×10^{18} p/cm^2. Observation of electron microscope foils, obtained at various positions along the proton pathlength, has shown that the average void diameter increased with increasing number of atom displacements, but that the void density remained constant. Calculated volume swelling ranged from 0.2 to 5%, depending on the number of displacements. In addition to voids, irradiation-produced dislocation loops and small precipitate particles on dislocations have been observed. (auth)

36938 (BAW-3809-8) METALLURGICAL EXAMINATION OF BORON-CONTAINING STAINLESS STEEL CLADDING FROM INDIAN POINT CORE A. Final Report, Volume 3 of 3 Volumes. Staehle, R. W. (Ohio State Univ., Columbus); Wulleart, R. A.; Perrin, J. S.; Lombard, J. R. (Battelle Memorial Inst., Columbus, Ohio). Feb 1970. Contract AT(30-1)-3809. 133p. Dep. CFSTI.

For Babcock and Wilcox Co., Research and Development Div., Lynchburg, Va.

The type-304 stainless steel cladding from Indian Point Core was examined metallurgically. This cladding was of special interest because it contained 250 ± 100 ppM boron as distributed poison. The evaluation included visual examination, corrosion tests in boiling HNO_3, potentiostatic polarization tests, creep tests, and electron microscopic examination of thin metal foils and of replicas from fractured surfaces of both irradiated and nonirradiated material. The corrosion and electrochemical tests showed that irradiation greatly increased the corrosion attack at grain boundaries. The mechanical testing and electron metallography showed brittle behavior in the temperature range of 600°C. (auth)

36939 (IN-1397) INTERIM REPORT OF POST-IRRADIATION RESULTS OF ATR BERYLLIUM SURVEILLANCE PROGRAM. Korth, G. E.; Beeston, J. M. (Idaho Nuclear Corp., Idaho Falls). May 1970. Contract AT(10-1)-1230. 25p. Dep. CFSTI.

Results of examinations of specimens from five capsules irradiated to 2 to 5×10^{21} n/cm^2 (E > 1 MeV) are presented. These are initial results from 64 capsules being irradiated to high fluence to establish the service life for the ATR reflector beryllium. The results gave a linear ($\Delta L/L$) growth rate of 0.02 to 0.03 percent per 10^{21} n/cm^2 fluence. The density change of 0.05 to 0.07 percent per 10^{21} n/cm^2 was consistent with the linear change. The compressive yield and ultimate strengths were essentially identical at 4 to 5×10^{21} n/cm^2 with little plastic ductility, although the specimens had the capacity to absorb compressive impact energy delivered at about 9 kg-m per blow. The swelling threshold decreased with irradiation and appeared at these fluences to be dependent upon the grade of beryllium. Mechanical twinning was a prominent mode of deformation in the compression testing of irradiated beryllium. (auth)

36940 (ORNL-4520, pp 97-133) MECHANICAL PROPERTIES OF ALLOYS IN REACTOR ENVIRONMENTS AND DEVELOPMENT OF LMFBR CLADDING AND STRUCTURAL MATERIALS. (Oak Ridge National Lab., Tenn.).

From Fuels and materials development program quarterly progress report for period ending December 31, 1969.

Samples of austenitic stainless steel are being irradiated in the Oak Ridge Research Reactor (ORR), the High Flux Isotope Reactor (HFIR), and the Experimental Breeder Reactor-II (EBR-II). Experiments have been designed for each reactor to obtain the desired exposure temperatures. Type 304 stainless steel specimens were injected with 20×10^{-6} atom fraction He in a cyclotron before irradiation in the EBR-II at 390°C to a fast fluence of 8.5×10^{21} neutrons/cm^2. A duplicate specimen that did not contain He was irradiated under identical conditions, and the resulting samples were examined by transmission electron microscopy. The voids were smaller and more numerous in the sample injected with He. The calculated changes in density were about the same. Accumulated observations from electron microscopy studies of several irradiated metals, including Al, Ni, V, Fe, and austenitic stainless steels, have revealed that void formation generally is not homogeneous. Comparative samples of type 304 stainless steel in the cold-worked and annealed conditions were irradiated in EBR-II at 400°C to a fluence of 2.8×10^{22} neutrons/cm^2. The measured change in density and the observed density of voids were smaller in the cold-worked samples. Samples of type 316 stainless steel were irradiated in the ORR to a fluence of 1.4×10^{21} neutrons/cm^2 (>1 MeV). Postirradiation tensile and stress-rupture properties show that the rupture life and the fracture strain were reduced by irradiation. The biaxial stress-rupture properties of annealed specimens without defects from the second batch of 0.2% Ti-modified type 304L stainless steel tubing fabricated at ORNL were determined. It was found that planetary-swaged and cold-drawn tubing, annealed 1 hr at 925°C, have essentially the same rupture times; however, the planetary-swaged material tends to exhibit slightly higher uniform and total circumferential strain. Annealing planetary-swaged tubing at either 925 or 1038°C produces rupture lives and ductilities that are indistinguishable from each other. A large fraction of the total circumferential strain exhibited by this tubing is due to uniform straining of the tubing before local wall thinning, or necking, occurs. The minimum observed ductilities of these tubes, which were essentially free from discontinuities that could be determined ultrasonically, are higher than those observed earlier on tubes that contained discontinuities. (auth)

36941 (WANL-TME-1655) IRRADIATION EFFECTS ON THE MECHANICAL PROPERTIES OF S-200-GRADE BERYLLIUM AND LOCKALLOY AT CRYOGENIC TEMPERATURES. Shogan, R. P. (Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.). Sep 1967. 56p. Dep. CFSTI.

Neutron irradiation of S-200-grade beryllium and Lockalloy was performed to determine its effects on these NERVA reactor reflector materials. Specimens were irradiated under liquid nitrogen (140°R) at the Ground Test Reactor in two separate tests, yielding average neutron fluences (E > 1 Mev) of 2.4×10^{17} n/cm^2 and 7.6×10^{17} n/cm^2. The first test consisted of 154 tensile and 24 flexure beryllium specimens, while the second contained 140 tensile, 24 compression, 36 flexure and 12 bi-axial brittle fracture beryllium specimens and 41 Lockalloy tensile specimens. About one-half of these specimens were controls (unirradiated). Tests were made at 140, 240, 340, 440, and 540°R without prior warming, except where effects of annealing on the 140°R properties were being studied. Radiation increased the ultimate tensile strength of beryllium at 340 and 440 and lowered it at 140°R. Tensile yield strengths increased sharply with decreasing temperature after irradiation. At 340°R, the lowest temperature at which yield strength could be measured, the increase was 56%. Nil ductility was found below 340°R. The notched tensile strength was increased at all but the 140°R test temperature for the lower neutron dose. At the higher dose, little effect was found except for a decrease at 140°R. While the flexure strength decreased at 140°R, the compressive yield strength increased by 171%. Neither the ultimate compressive strength nor the plastic strain in compression showed significant radiation effects. The plane strain fracture toughness decreased a maximum of 44% at 140°R. Annealing at 540°R (room temperature) for 1,020 minutes (17 hours) restored the 140°R tensile strength of the beryllium. Most of the other 140°R properties recovered after one hour anneals at 540°R. Few of the properties were significantly changed by the irradiation when tested at 540°R. The mechanical strength of the Lockalloy was not significantly affected by the irradiation. The unirradiated material was found to be very brittle with less than 0.1% plastic strain under all test conditions. For this reason, it is not recommended for use as a reflector material. (auth)

36942 ELONGATION BY SELF-IRRADIATION OF α-PLUTONIUM AT 1.5°K. Jacquemin, J.; Lallement, R. (CEN, Fontenay-aux-Roses, France). Phys. Lett., A; 32: 181-2(9 Jun 1970). (In French).

Measurements with strain gages at 1.5°K of α-Pu showed that the length increased twice as fast at 1.5°K as at 4°K. This phenomenon is possibly linked to the recovery between 3.75°K and 4°K of a certain amount of the interstitials created by self-damage. (auth)

36943 MEASUREMENTS OF THE HARDENING OF ALUMINUM SINGLE CRYSTALS UNDER LOW TEMPERATURE REACTOR IRRADIATION. Diehl, Joerg; Leitz, Christof; Decker, Wolfgang (Max-Planck-Institut fuer Metallforschung, Stuttgart). Z. Metallk.; 61: 443-50(Jun 1970). (In German).

For studies of the irradiation hardening of metals at low temperatures tensile testing machines were designed for use in the low temperature irradiation facilities of research reactors. These machines allowed remote handling of tensile specimens within closed cryostats and the measurement and recording of the tensile force (at a constant strain rate) free of frictional forces. Stress-strain-curves of aluminum single crystals irradiated at low temperatures, which were measured with this equipment, are described. The most important feature of these curves, a yield phenomenon connected with Lüders-Band propagation, is studied in more detail. (auth)

36944 CRYOGENIC TENSILE PROPERTIES OF IRRADIATED BERYLLIUM, TITANIUM, AND ALUMINUM ALLOYS. Coombe, J. R.; Shogan, R. P. (Westinghouse Electric Corp., Pittsburgh). Nucl. Appl. Technol.; 9: 396-401(Sep 1970).

The effects of temperature on radiation characteristics and

subsequent material properties after cryogenic temperature irradiation are analyzed. The materials tested to date have included hot pressed block beryllium, titanium–5 percent aluminum 2.5 percent tin ELI (A110AT), and an aluminum alloy 2219. These materials have been irradiated at 140°R and tensile tested without any intervening warm-up. Data on material irradiated and tested at low temperature and room temperature are presented. The properties investigated have included ultimate tensile strength, percent elongation, and fracture toughness. Usually, ductility and the decrease in the magnitude of this property as a function of irradiation is of more vital interest to the designer. The experimental program conducted for NERVA candidate materials is reported and areas of additional investigations for application to advanced NERVA designs are briefly discussed. (auth)

Ceramics and Cermets

Refer also to abstracts 36855 and 36858.

36945 (ORNL–4520, pp 85–96) LMFBR FUEL ELEMENT DESIGN AND MODEL DEVELOPMENT. (Oak Ridge National Lab., Tenn.).

From Fuels and materials development program quarterly progress report for period ending December 31, 1969.

The FMØDEL computer code was used to study the performance characteristics of a typical liquid-metal-cooled fast breeder reactor (LMFBR) fuel pin. Radial temperature distributions and linear heat rates were calculated for different positions along the axis of the pin, and gap closure kinetics were examined by use of different assumptions regarding fuel strength and neutron flux. The stress-strain distribution in the cladding was also examined with respect to cladding thickness. Work was begun to improve available analytical models for predicting fuel swelling and gas release. Electron microscopy was used to examine irradiated mixed oxide fuel to determine the size and density distribution of bubbles of fission gas. An equation based on British data was developed that can be used to describe the creep rate of type 316L stainless steel out-of-reactor at 600 to 700°C, for use in modeling studies of British irradiation tests. (auth)

Corrosion and Erosion

Refer also to abstracts 36210 and 36859.

36946 (TRG-Report–2010) DESORPTION STUDIES ON NUCLEAR GRAPHITE. Ashton, B. W.; Labaton, V. Y. (United Kingdom Atomic Energy Authority, Culcheth (England). Reactor Group); Smith, A. (Surrey Univ., London (England)). May 1970. 19p. (CONF-700407–2). Dep. CFSTI (U. S. Sales Only).

From 3rd International Conference on Industrial Carbon and Graphite, London, England.

The gases desorbed from three nuclear graphites in the as-received state and after irradiation in $CO/CH_4/CO_2$ coolants were identified and measured. The results were examined in terms of the effects of graphite type, and the importance of surface complexes in inhibition of the radiolytic graphite/CO_2 reaction. (auth) (UK)

36947 UPWARD DRILLING OF GLASS CONTACT REFRACTORIES. Begley, Edward R.; Herndon, Philip O. (Corhart Refractories Co., Louisville, Ky.). Amer. Ceram. Soc. Bull.; 49: 633–7(Jul 1970).

A testing procedure is described and studies are presented on rates of upward drilling and metal line corrosion of six refractory compositions in contact with a soda-lime glass at 1300, 1400, and 1450°C. Results indicated a strong association of metal line and upward drilling rates at all testing temperatures. Observations by previous authors regarding effects of bubble size (from model systems) are affirmed. Observations are made on drilling effects associated with cracks and joints. (auth)

Preparation and Fabrication

Refer also to abstracts 36197, 36345, 36869, 38473–38475, and 38478.

36948 (ALO–(2510)–8) SILICON GERMANIUM THERMOELECTRIC MATERIALS AND MODULE DEVELOPMENT PROGRAM. 8th Quarterly Report, October 1, 1969–December 31, 1969. (RCA, Harrison, N. J.). Contract AT(29-2)-2510. 66p. Dep. CFSTI.

Activities in the program are organized in subprograms for development of SiGe thermoelectric materials, Air-Vac module development, and cascaded converter development. During the report period the emittance of N and P SiMo samples subjected to a range of operating and processing conditions was determined. It was determined by means of a series of compatibility tests that platinum foils reacted with the silicon, phosphorus, and germanium components of SiGe, and thus was not suitable for use in a SiGe converter without further development effort. The fabrication of the C-4 converter was completed on schedule and performance testing initiated. The MinK (C-2) and the foil (C-3) insulated 5-watt converters were operated in nitrogen to simulate the performance in air to give a measure of the capability of converters with each insulation performing in launch pad environments. A zirconia base fibrous insulation was tested to determine its high temperature performance characteristics in both vacuum and nitrogen. The material looks promising at temperatures up to the limits of the converter operation. (J.R.D.)

36949 (ANL–7649) PILOT-LOT FABRICATION OF ZPPR OXIDE-ROD ELEMENTS. Ayer, J. E.; Hins, A. G.; McCuaig, F. D. (Argonne National Lab., Ill.). Jan 1970. Contract W-31-109-eng-38. 25p. Dep. CFSTI.

The development and manufacture of oxide-rod fuel elements and gamma-scan standards for the ZPPR reactor are discussed. A total of 52 elements: 30 oxide-rod fuel elements and 22 gamma-scan elements, were made. All UO_2 and $(U,Pu)O_2$ pellets were encapsulated in Type 304L stainless steel jackets, with helium at atmospheric pressure. The UO_2 and $(U,Pu)O_2$ pellets were fabricated by a cold-press and sinter technique that produced acceptable pellets without centerless grinding. The pellets, produced with a length-to-diameter ratio of 1.5, had a theoretical density of about 95%. A loading technique was developed to protect the outside of the jacket tube and weld zone from plutonium contamination. A special end plug was designed to prevent thinning of the jacket tube wall or an increase of the outside diameter in the welded area, and to produce a finished element of a predetermined overall length. The elements were dimensionally checked, x-rayed, leak detected, and surveyed for alpha contamination on the external surfaces before final acceptance. (auth)

36950 (EIR–171) PLUTONIUM FUEL PROGRAM. Annual Report, 1969. (Eidgenoessisches Institut fuer Reaktorforschung, Wuerenlingen (Switzerland)). May 1970. 105p. (In German). Dep. CFSTI (U. S. Sales Only).

The progress made in 1967 to 1968 in the development and characterization of plutonium fuels for fast breeder reactors is reported. The sol-gel method was used for the production of the U–Pu mixed carbides. The steps described in this production process were the preparation of UO_2-sols by precipitation and peptization, preparation of PuO_2-sol by the ORNL method, carbon dispersions, preparation of spherical gel particles, and the carbothermic reduction of UO_2. The mixed carbides were characterized by chemical, x-ray, and metallographic analyses, density determination, homogeneity studies, porosity, and determination of the mechanical properties. The FILOS, the irradiation device in the SAPHIR, was described. The gamma scanning method and the microdrill cells for the post-irradiation studies were described. The methods used for the irradiation of the U–Pu mixed oxides were also discussed. The special devices of the Pu laboratories were briefly indicated. (J.S.R.)

36951 (ORNL–4520, pp 3–56) DEVELOPMENT OF FAST-REACTOR OXIDE FUELS. (Oak Ridge National Lab., Tenn.).

From Fuels and materials development program quarterly progress report for period ending December 31, 1969.

A total of 1.2 kg of Pu sol and 9.5 kg of 93% enriched U sol was prepared to meet the demands of the fast-reactor oxide fuels program. About 1.5 kg of dense microspheres containing $(U, Pu)O_2$ were prepared for loading into fuel pins for the Experimental Breeder Reactor-II (EBR-II). Five Sphere-Pac fuel pins and three pellet fuel pins were completed, all with 3-in.-long fuel columns and all to be irradiated in the Engineering Test Reactor (ETR). Plans were developed for fabricating 19 unencapsulated fuel pins for irradiation in a 37-pin subassembly in the EBR-II. Planning, scheduling, and procurement of hardware and raw materials were the principal activities during the quarter. Procedures for loading the microspheres and for fabricating the pellets were also developed. Gas releases as high as 0.5 cm^3/g were previously observed. Further work on control of gas release and the ratio of O: metal indicates that cooling in an atmosphere for pure Ar after adjustment of the ratio of O: metal decreases the susceptibility of the fuel to reabsorption of gas and therefore results in a lower measured gas release. A sol-gel Sphere-Pac capsule that contained $(U,Pu)O_2$ attained a calculated burnup of 8.5 fissions per initial actinide metal atom (FIMA) in the ETR, and the irradiation of the capsule is continuing at a peak heat rate of 15 kW/ft with a target of 10% FIMA burnup. The third instrumented capsule for irradiation in the Oak Ridge Research Reactor (ORR), which contains one Sphere-Pac fuel pin and one sol-gel pellet fuel pin of the same composition and smear density, was completed and installed into the ORR. It began operation

late in the quarter. Six fuel pins that contain unirradiated sol-gel-derived $(U,Pu)O_2$ pellets or Sphere-Pac microspheres were subjected to power transients at the Transient Reactor Test Facility (TREAT). No failures occurred even though two Sphere-Pac pins were subjected to a transient that probably melted 50 to 60% of the fuel in the peak power regions. The capsules from the experiments in TREAT were neutron radiographed, and postirradiation examination of the fuel pins was started. Encapsulated Sphere-Pac $(U,Pu)O_2$ fuel pins were tested in subassembly X050 in the EBR-II to a peak burnup of 3.4% FIMA. Cesium was observed in a white, crystalline deposit on the surface of a metallographic specimen prepared from an irradiated fuel pin. This white, crystalline deposit formed on irradiated $(U,Pu)O_2$ fuel when unmounted sections cut from the fuel pins were allowed to stand several days before mounting and polishing. Gamma spectrum analysis of the white material revealed ^{134}Cs and ^{137}Cs activity only. (auth)

36952 (ORNL-4520, pp 57-83) DEVELOPMENT OF HIGH-PERFORMANCE LMFBR FUELS. (Oak Ridge National Lab., Tenn.).

From Fuels and materials development program quarterly progress report for period ending December 31, 1969.

The sinterability of (U,Pu)N powders derived from an alloy was compared with that of powders derived from mechanical mixtures of UN and PuN. With proper pretreatment, the mechanically mixed materials can be sintered to reasonably dense structures that have microstructures and precision lattice parameters identical to those obtained from powder synthesized from a U–Pu alloy of the same molar composition. Difficulty was experienced in synthesizing nitride powders from the alloy in that they contain small concentrations of free metal after synthesis is apparently complete. The effects of annealing upon the lattice parameter of PuN and the phases derived when powders are synthesized from U–Pu alloy are under study. Vanadium and V_2N were found to be stable in the presence of UN, but not in the presence of U_2N_3. A new phase, UVN_2, was found to be stable in the presence of U_2N_3, UN, VN, or V_2N, but not in the presence of V or U. The UN–V_2N–V and UN–UVN_2–V_2N three-phase regions form good buffering systems for use of nitride fuels with stainless steels. (auth)

36953 (ORNL-TM-2922) FABRICATION OF ORNL SERIES I IRRADIATION TEST CAPSULES FOR EXPERIMENTAL BREEDER REACTOR II. Moore, W. L.; Preston, M. K.; Sease, J. D. (Oak Ridge National Lab., Tenn.). Jul 1970. Contract W-7405-eng-26. 76p. Dep. CFSTI.

Five capsules were fabricated for irradiation tests in the Experimental Breeder Reactor II. Each capsule contained one stainless steel fuel pin loaded by the Sphere-Pac process with 73 g of coarse and fine grades of $(U_{0.80}, Pu_{0.20})O_{1.98}$ (enriched 93%) microspheres produced by the ORNL sol-gel process. Each fuel pin contained an extensometer for measuring the elongation of the fuel column. A sodium heat-transfer bond filled the annulus between the fuel pin and the capsule wall. The fuel pins and capsules were inspected by nondestructive techniques: helium leak check, radiography, gamma-attenuation scanning, and dye penetrant. Significant fabrication problems resolved included effecting the sodium bond, maintaining the sodium annulus, and tack welding the fuel pin to the capsule. (auth)

36954 (RCN-115) PREPARATION OF TUNGSTEN COATED DYSPROSIA AND ITS INCORPORATION IN URANIUM-DIOXIDE. Majoor, E. B. M. (Reactor Centrum Nederland, Petten). Feb 1970. 28p. Dep. CFSTI (U. S. Sales Only).

Dy_2O_3 may be applied as burnable poison in UO_2 fuel elements. To prolong the effect it is desired to use discrete Dy_2O_3 particles with neutron self-shielding. Dissolution of the Dy_2O_3 particles in the surrounding matrix must be avoided. The preparation of spherical Dy_2O_3 particles coated with tungsten as a reaction barrier is described. The Dy_2O_3 particles were stabilized with Y_2O_3, speriodized in an argon plasma torch, and coated with a vapor deposition process in a fluid bed furnace. Experiments show that the coated particles are compatible with UO_2 to above 2000°C. (auth)

36955 IMPROVEMENTS IN OR RELATING TO CERAMICS. George, Dennis (to United Kingdom Atomic Energy Authority). British Patent 1,192,096. 20 May 1970. Filed 15 Feb 1968.

The practical problems in the manufacture of formed oxide bodies are very considerable when temperatures in excess of about 2000°C are involved. In this connection an improved process is described. A hydrous sol of the oxide stabilised with acid is formed, the sol is converted to gel, the gel is heated to convert it to solid oxide, the temperature being such as to avoid sintering, a green oxide body is formed from the decomposed gel, and this body is sintered at 1700 to 1900°C. The process is applicable only to those oxides which can form hydrous oxide sols stabilized by acid cations; these include those of the actinide metals, the lanthanides, and titanium, hafnium, zirconium, and aluminum. A zirconia sol may be conveniently prepared by the method described in B.P. 1,181,794, and an alumina sol by the method described in B.P. 1,174,648. Thoria sol may be purchased under the name colloidal thoria. A convenient process for gelling the sols is to allow them to dry at up to 100°C. Decomposition of the gel may be effected at 950 to 1100°C to remove combined water and acid cations. If a stabilizing oxide, such as MgO, CaO, or Y_2O_3, is necessary, a solution of a thermally decomposable salt, such as nitrate, may be added to the sol. If a mixed oxide product is required this can be achieved in the same way, or the two sols may be mixed. Binders may be used in forming the green body. The products are characterised by high density. By way of example the preparation of a tube of thoria stabilized with yttria is described. (UK)

36956 COBALT–TUNGSTEN CARBIDE ALLOY AND PROCESS. Holtz, Frederick C. Jr. (to IIT Research Inst.). U. S. Patent 3,512,962. 19 May 1970. Filed 3 Jan 1966.

The preparation from prealloyed powders of fully dense cobalt-tungsten carbide alloys, characterized by a microstructure exhibiting a substantially uniformly dispersed tungsten carbide phase which has a grain size less than 5 microns is described. An atomized molten alloy charge consisting essentially of from 40 to 70 percent by weight of tungsten carbide, the balance being cobalt, is rapidly quenched and the solidified particles are subjected in a suitable container to the step of hot consolidation to produce a wrought alloy directly from prealloyed powder. (auth)

36957 PREPARATION OF LOW GRADE U_3O_8 AND Pb ORES BY IMPACT CRUSHING. Andreas, A. E. Can. Mining J.; 90: 63-5(Aug 1969).

Average U content is somewhat more than 12 ounces of U_3O_8 per ton. The U is concentrated in a flat-lying 11.5 foot thick bed which is covered by an average of 20 feet of rock, above which is an average of 25 feet of alluvium. Thus the ratio by volume between overburden and ore is 4:1. For these reasons the primary gyratory crusher was located underground. Ore is reduced to a maximum size of 14 in. Material is then conveyed to the top of the storage silos where it is screened. The $-\frac{1}{4}$" is separated and considered as waste while the $+\frac{1}{4}$" to $-1\ \frac{3}{16}$" and the $+1\ \frac{3}{16}$" sizes are stored for further processing. A sink and float process separates the limestone from the shale. Details of the crushing and screening plants are also given. (F.S.A.)

36958 PROCESS FOR PREPARING URANIA–PLUTONIA NUCLEAR FUEL. Triggiani, Leonard V.; Sanchez, Moises G. (to W. R. Grace and Co.). U. S. Patent 3,514,412. 26 May 1970. Filed 25 Sep 1967.

A process for preparing microspheres of urania-plutonia is described. The microspheres were prepared by impregnating a matrix of urania with a solution containing plutonia. The adsorbed plutonium was precipitated within the urania pores with a suitable material. The impregnated microspheres were then washed, dried, and sintered to recover mixed oxide microspheres. (auth)

36959 OPTIMUM CONFIGURATION OF AN ANNULAR NUCLEAR FUEL ELEMENT. Melese-D'Hospital, G. (Gulf General Atomic Inc., San Diego, Calif.). Nucl. Eng. Design; 12: 153-66(1970).

In all-ceramic fuel elements for high temperature gas-cooled reactors, an unfueled moderator spine is often surrounded by a fuel compact consisting of a dispersion of fuel and fertile material in a moderator matrix with a ceramic cladding. For given fuel and fertile loading in a fuel element of given outer size, physical reasoning suggests that there might be an optimum configuration for maximum heat flux with given temperature or stress limitations. If the fuel is concentrated in a thin compact at the outside, the heat path is small but the thermal conductivity is poor since the fuel conductivity is usually low; if the fuel is distributed homogeneously, the conductivity is high but the heat path is longer. Analysis shows that such an optimum exists as long as the ratio of thermal conductivities of fuel and matrix is smaller than about $\frac{1}{2}$. For a greater fuel conductivity the maximum heat flux is reached when the fuel is concentrated near the outer surface. These results are valid whether the maximum or the average fuel compact temperatures are limiting. Simple analytical formulae are derived in the text for a slab while results for cylindrical and spherical geometry are given in an appendix. (auth)

36960 ZIRCONIA TAILORED FOR THERMAL SHOCK RESISTANCE. Johns, H. L.; King, A. G. Ceram. Age; 86: No. 5, 29-31(May 1970).

Experiments are described in which MgO–ZrO_2 ceramics containing 27.5 to 61.0% ZrO_2 were prepared by firing at 350°F. The samples were then tested thermally by heating to 1900°F and

quenching to room temperature in water. Only specimens containing 45% and above of monoclinic ZrO_2 survived the test. The tests were conducted to show that thermal shock resistance and other properties can be varied widely by control of ZrO_2 content and processing. (J.R.D.)

36961 PRESSURE-DENSIFICATION IN TANTALUM CARBIDE. Leipold, Martin H. (Univ. of Kentucky, Lexington); Becher, Paul F. Amer. Ceram. Soc. Bull.; 49: 647-51(Jul 1970).

Densification of tantalum carbide during hot-pressing was found to be very dependent on minor variations in composition, as well as particle size, temperature and pressure. The variations were in carbon to metal ratio and in oxygen content and increases in either enhanced densification. Grain growth was also affected by such differences. In addition, other factors caused variability which could not be explained by these aforementioned differences. (auth)

Properties Evaluations

Refer also to abstracts 36523, 36876, 36904, 37002, 37552, 38473–38475, 38478, and 38542.

36962 (AD-702884) EFFECT OF WATER VAPOR ON THE VOLATILITY OF FISSION PRODUCT OXIDES. Furey, Donald A.; Bloore, Ernest W. (Ballistic Research Labs., Aberdeen Proving Ground, Md.). Feb 1970. 13p. (BRL-MR-2022). CFSTI.

Volatilities of the oxides of antimony, tin, and ruthenium in the presence of water vapor were studied by the transpiration method. The volatility of Sb_2O_3 was determined at 600C, but no volatile hydroxide species was detected at this temperature. No volatile hydroxide species was detected for Sb_2O_4, RuO_2, or SnO_2 at temperatures up to 930C. (auth) (USGRDR)

36963 (CEA-R-3765(2)) STUDY OF THE MIXED URANIUM–PLUTONIUM MONOCARBIDES CONTAINING SMALL AMOUNTS OF ZIRCONIUM. Bocker, Shimon (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Jun 1970. 114p. (In French). Dep. CFSTI (U. S. Sales Only).

Thesis. Submitted to Univ. of Paris, Orsay, France.

Small additions of zirconium to the uranium–plutonium monocarbide improve some properties, such as atmospheric corrosion, hardness, and particularly compatibility with Type 316 stainless steel. However, properties such as expansion coefficient and melting point are only slightly changed. The relative percentage of (Pu/U + Pu) in the monocarbide was fixed at 20 percent. Two processes of fabrication were used: casting in an arc furnace, and sintering from the metal hydrides. (auth) (France)

36964 (CEA-R-3953) MECHANICAL PROPERTIES OF URANIUM AND PLUTONIUM BASED CERAMICS. Padel, Andre (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Jun 1970. 84p. (In French). Dep. CFSTI (U. S. Sales Only).

The sound velocity and the elastic constants of UC, UN, UO_2, and (UC, UN) are measured at room temperature as a function of porosity and the influence of the oxygen content on the elastic constants of (U, Pu)$O_{2\pm x}$ is determined. Young's modulus and internal friction are measured as a function of temperature between 25°C and 1,300°C for UC, UN, UO_2, $(U_{0.82}\ Pu_{0.18})N$ and $(U_{0.80}\ Pu_{0.20})O_{2\pm x}$. (auth) (France)

36965 (COO-716-58) THE INCONGRUENT VAPORIZATION OF NONSTOICHIOMETRIC $YbC_{1.25+y}$. Haschke, John M.; Eick, Harry A. (Michigan State Univ., East Lansing. Dept. of Chemistry). Contract AT(11-1)-716. 13p. Dep. CFSTI.

The vapor pressure of gaseous ytterbium in equilibrium with $YbC_{1.25+y}$(s) ($0.12 < y < 0.16$) and YbC_2(s) was measured by a target collection Knudsen effusion technique over the temperature range 1056 to 1337°K. Third law enthalpies of vaporization and enthalpies of formation are presented and discussed. (auth)

36966 (DP-Report-67) THE USE OF MOLYBDENUM DISILICIDE AS A BRAZING MEDIUM FOR FUEL BOXES. Project DRAGON. Burnett, R. C.; Marengo, G. (Atomic Energy Establishment, Winfrith (England)). Nov 1961. 13p. Dep. CFSTI.

Results of research on $MoSi_2$ for use as a brazing material for graphite fuel cans are presented. The effects of $MoSi_2$ on graphite at high temperatures were examined along with thermal cycling effects on $MoSi_2$ in graphite joints and the effects of high temperature on the silicide braze material. It was found that the $MoSi_2$ brazing material can be used under some reactor conditions. The material was not subjected to high temperature irradiation. (J.R.D.)

36967 (EURFNR-740) PRODUCTION AND PROPERTIES OF CERMETS WITH IDEALIZED STRUCTURE IN THE SYSTEM UO_2/Cr. Weimar, P.; Thuemmler, F. (Kernforschungzentrum, Karlsruhe (West Germany). Institut fuer Material- und Festkoerperforschung). Translation of report KFK-1112. 24p. Dep. CFSTI.

Work Performed under United States–Euratom Fast Reactor Exchange Program.

This paper was abstracted from the original language and appeared in NSA as 24: 19497.

36968 (HMI-B-93) MOBILITY OF RARE GAS ATOMS IN NEUTRON-IRRADIATED IONIC CRYSTALS AND NUCLEAR FUEL MATERIALS. Felix, Fred W. (Hahn-Meitner-Institut fuer Kernforschung, Berlin (West Germany)). Jun 1970. 130p. (In German). Dep. CFSTI (U. S. Sales Only).

Results obtained to 1968 from measurements of the post-activation diffusion of rare gases in solids are summarized. The method is presented by a short survey on the theoretical background and by a detailed description of the experimental technique. Examples are given for typical deviations from ideal diffusion behavior, e.g., the diffusion in an evaporating crystal. Finally, quantitative results are presented on rare gas diffusion in single crystals of alkali halides, alkaline earth fluorides, CaO, and nuclear fuel materials (UO_2, UC, ThO_2). (auth)

36969 (NEDO-10173) CURRENT STATE OF KNOWLEDGE HIGH-PERFORMANCE BWR ZIRCALOY-CLAD UO_2 FUELS. Williamson, H. E.; Ditmore, D. C. (General Electric Co., San Jose, Calif. Reactor Fuels and Reprocessing Dept.). May 1970. 42p.

It will be shown that the area of technology demonstrated by irradiations of Zircaloy-clad UO_2 fuel rods and pins in reactors, loops, and capsules goes beyond the combination of fuel rod power and exposure that will be experienced in modern boiling water reactors not only for normal continuous operation, but also for anticipated power transients. A larger quantity of data at these combinations of fuel rod linear power and burnup will become available in the future but the recorded successful irradiations demonstrate that not only safe but reliable fuel can be designed for modern boiling water reactor conditions. A value of 1% plastic strain of Zircaloy cladding is conservatively defined as the limit below which fuel damage due to overstraining is not expected to occur. The linear heat generation rate required to cause this amount of cladding strain is calculated to be ~28 kW/ft in fresh fuel. The basis for this definition and its inherent conservatism are demonstrated. (auth)

36970 (ORNL-4520, pp 187-91) DEVELOPMENT OF FAST-REACTOR NEUTRON-ABSORBER MATERIALS. (Oak Ridge National Lab., Tenn.).

From Fuels and materials development program quarterly progress report for period ending December 31, 1969.

The structural changes that result from annealing of B_4C powders are being investigated. Boron carbide powders have a B:C ratio of 3.62 undergo a maximum reduction in density of 5% when they are annealed at 2000°C. Previously reported unidentified phases in experimental B_4C powders produced by arc melting have been shown to be W and Cu. Thermal irradiation testing of B_4C powders in the Oak Ridge Research Reactor (ORR) has begun. The initial experiment was removed from the reactor late in this reporting period, and postirradiation testing is now in progress. Pellets are being prepared from specific types of B_4C powders for irradiation in the Experimental Breeder Reactor-II (EBR-II) later in 1970 after the reactor goes to higher power. (auth)

36971 (SC-DR-70-365) FILAMENT-REINFORCED CERAMICS: FABRICATION AND TESTING. Cyrus, W. L.; Moss, M.; Schuster, D. M. (Sandia Labs., Albuquerque, N. Mex.). Jun 1970. 18p. Dep. CFSTI.

The feasibility of preparing metal filament-reinforced ceramics by plasma spraying has been demonstrated. Approximately 13 volume percent of either 0.005-inch-diameter tungsten or molybdenum wire was incorporated into an aluminum oxide matrix by a process of alternate filament winding and spraying. Filament degradation, which results from fiber-matrix interaction in such processes as hot pressing, was not observed, and strength of the filaments was retained in the composite. A significant change in the mode of failure of the brittle ceramic was observed. Although a network of cracks appeared at the failure strain of unreinforced alumina, catastrophic crack propagation was suppressed in the reinforced ceramic. The load-carrying capability of the filaments was solely responsible for the observed increases in tensile strength of the composite, but such increases were evident at strains greatly exceeding the ultimate strain of the ceramic, i.e., after cracking of the matrix. (auth)

36972 (SC-T-70-4023) OPTICAL METHOD FOR ESTIMATION OF THE AMORPHOUS COMPONENT IN PYROLYTIC CARBON. PART I. Koizlik, K.; Schulze, N. A.; Gruebmeier, H. B.; Scheidler, G. P. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorwerkstoffe). Translated by W. G. Stripp for Sandia Labs., Albuquerque, N. Mex., from report JUL-589-RW. 18p. Dep. CFSTI.

This paper was abstracted from the original language and appeared as 24: 3022.

36973 (Y-1726) METHOD OF STRESS RELAXATION TESTING. Reeves, C. A. Jr. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). 24 Jun 1970. Contract W-7405-eng-26. 28p. Dep. CFSTI.

Two separate series of tests were performed to determine the stress relaxation properties of a uranium alloy (90 wt % U, 7½ wt % Nb, 2½ wt % Zr) at both room and elevated temperatures. Only the testing procedure and initial treatment of data are discussed. (auth)

36974 (ZJE-75) THE USE OF AN UNCONVENTIONAL HEAT TREATMENT FOR MECHANICAL PROPERTIES STABILIZATION OF THE Al-Si-Mg ALLOY AT TEMPERATURES UP TO 150°C. Jicinsky, P. (Skoda Concern, Pilsen (Czechoslovakia). Nuclear Power Plants Div.). 1970. 10p. Dep. CFSTI (U. S. Sales Only).

A special heat treatment method used for mechanical properties stabilization of the Al-Si-Mg alloy is described. This alloy was used as a structural material of the nuclear reactor heavy water tank, working at elevated operating temperatures. (auth)

36975 DESORPTION SPECTRA OF GAS MIXTURES CHEMISORBED ON TUNGSTEN. Medana, Riccardo; Ricca, Franco (Univ., Turin). Atti Accad. Sci. Torino. I. Cl. Sci. Fis., Mat. Natur.; 103: 717-33(Jul-Oct 1969). (In Italian).

The desorption spectra obtained from mixtures of H_2, N_2, and CO chemisorbed on a polycrystalline filament of tungsten were analyzed by use of a mass microspectrometer with radiofrequency of the omegatron type. The hydrogen was rapidly chemisorbed in the β_2 form and more slowly in the β_1 form, blocking the chemisorption of β_1-N_2. β_2-H_2 was then gradually removed by the effects of the adsorption of CO. The adsorption of CO and of H_2 seemed to modify the state of the β_2-N_2, initially adsorbed, reducing significantly the bonding energy. Only the desorption spectrum of CO seemed to preserve unvaried the characteristics that it presented in the adsorption of the pure gas. (tr-auth)

36976 ADSORPTION OF SIMPLE MOLECULES ON GRAPHITE. II. VARIATION OF THE ADSORPTION POTENTIAL AS A FUNCTION OF THE NUMBER OF ADSORBED LAYERS. Thomy, Andre; Duval, Xavier (Centre National de la Recherche Scientifique, Villers-Les-Nancy, France). J. Chim. Phys.; 67: 286-90 (Feb 1970). (In French).

The larger number of steps in the adsorption isotherms of krypton, xenon, and methane on homogeneous surfaces of exfoliated graphite allows the Champion and Halsey equation to be applied. The adsorption potential is found to decrease from one adsorbed layer to the next as $1/n^3$, n being the number of the layer. (auth) (France)

36977 RATE OF EVAPORATION OF CONGRUENTLY EVAPORATED COMPOSITIONS OF NIOBIUM MONOCARBIDE PHASES. Nikol'skaya, T. A.; Avarbe, R. G.; Vil'k, Yu. N. Teplofiz. Vys. Temp.; 8: 77-80(Jan-Feb 1970). (In Russian).

The rates of the congruent evaporation of six compositions of niobium monocarbide were determined at 2480 to 3300°K. The method of least squares was used to determine the relation of the logarithm of the rate of the congruent evaporation to the inverse temperature of the niobium carbide. (tr-auth)

36978 MEASUREMENT OF HEAT CAPACITY AT HIGH TEMPERATURES BY LASER FLASH METHOD. HEAT CAPACITY OF ALUMINA. Murabayashi, Masayuki; Takahashi, Yoichi; Mukaibo, Takashi (Tokyo Univ.). J. Nucl. Sci. Technol. (Tokyo); 7: 312-16(Jun 1970).

Measurement of heat capacity at high temperatures by the laser flash method is discussed with the view to improving accuracy. The samples were disks of sintered alumina. The heat capacity measurement was carried out at temperatures ranging from 25 to 700°C. The energy of the laser beam was determined with the use of a silicon photoelectric cell and a standard sample of pure iron. The experimental results are compared with the NBS standard data for alumina. Agreement is seen within experimental error, estimated to be ±1.5%. (auth)

36979 DEFORMATION AND ULTIMATE STRENGTH OF CONCRETE UNDER TRIAXIAL STRESSES. Launay, P.; Gachon, H.; Poitevin, P. (Compagnie Industrielle de Travaux, Paris). Ann. Inst. Tech. Batiment Trav. Publics; No. 269, 21-48(May 1970). (In French).

The measurements made on cubic specimens of concrete are described in order to study the deformability under service compression stresses and the rupture strength of the thick concrete walls used in nuclear reactor vessels. The deformability (Young's modulus, Poisson's ratio) was studied up to 500 bars in the three main directions on cubes having 140mm sides at 20, 40, and 60°C. The ultimate strength and the rupture mechanism under pluriaxial stresses were studied on cubes having 70 mm sides up to 2000 bars in all the 3 directions, with the same testing machine especially built. The specimens were concreted with the same materials as the 2 ½-scale models of the Bugey 1 vessel built in Chinon: CPAC 325 cement, silico-calcareous gravel having a maximum grain size of 16mm, but with two different batchings, the monoaxial nominal strength at 28 days varying in consequence from 300 to 450 bars. (auth) (France)

36980 PROPERTIES OF MOLYBDENUM SHEET WITH THE TWO-PHASE STRUCTURE AFTER ANNEALING. Boginich, O. E.; Metlitskii, V. A.; Statkevich, V. N. (Inst. of Electric Welding, Moscow). Metalloved. Term. Obrab. Metal.; No. 12, 59-61(1969). (In Russian).

The effects of annealing for 1 hour at 400 to 1400°C on the mechanical properties and microstructure of molybdenum alloyed with carbon and titanium were studied. After formation of the second phase with optimum heat treatments, ductility properties were studied. Plasticity increased with thermal treatments at 1100°C and corresponded to the temperature of the beginning of the recrystallization of the sheet molybdenum. The formation of the carbide phase interfered with the development of the recrystallization processes. (tr-auth)

36981 DISSOCIATION ENERGY OF VANADIUM AND CHROMIUM DICARBIDE AND VANADIUM TETRACARBIDE. Kohl, Fred J.; Stearns, Carl A. (Lewis Research Center, Cleveland). J. Phys. Chem.; 74: 2714-18(25 Jun 1970).

The Knudsen effusion method was used in conjunction with a double focusing mass spectrometer to study the vaporization of the vanadium-carbon and chromium-carbon systems over the temperature ranges 2417 to 2603 and 2083 to 2176°K, respectively. The molecular species VC_2, VC_4, CrC_2 were identified and experimentally determined third-law enthalpies were combined with published thermodynamic data to yield the dissociation energies: $VC_2(g) = V(g) + C_2(g)$, $D^0_0(V-C_2) = 570 \pm 20$ kJ mol^{-1}; $VC_4(g) = V(g) + 2C_2(g)$, $D^0_0(C_2-V-C_2) = 1193 \pm 22$ kJ mol^{-1}; $CrC_2(g) = Cr(g) + C_2(g)$, $D^0_0(Cr-C_2) = 445 \pm 18$ kJ mol^{-1}. Atomization energies were also calculated. Results are discussed in terms of the metal oxide-metal dicarbide bond strength analogy. (auth)

36982 HIGH-TEMPERATURE EVAPORATION AND THERMODYNAMIC PROPERTIES OF Cm_2O_3. Smith, P. K.; Peterson, D. E. (E. I. du Pont de Nemours and Co., Aiken, S. C.). J. Chem. Phys.; 52: 4963-72(15 May 1970).

Curium oxide has been shown to vaporize congruently as Cm_2O_3. Effusion measurements were carried out, using tungsten and molybdenum cells, over a temperature range from 1800 to 2600°K and a pressure range from 10^{-9} atm to 0.5 mm. The linear least-squares fit to the total volatility, calculated as Cm_2O_3, yields the equation $\log P(atm) = 7.32\ (\pm 0.26) - 29{,}050(\pm 590)/T(°K)$. The corresponding $\Delta H_{2200°K}$ and $\Delta S_{2200°K}$ were computed to be 133.0 ± 2.7 kcal/mole of gas and 33.5 ± 1.2 cal/deg · mole of gas, respectively. The predominant vaporization process is thought to be the formation of CmO(g) and O(g), based on estimates of the heat of formation of Cm_2O_3(s), comparison of experimental and estimated entropies of vaporization, consistency between second- and third-law heats of vaporization, and trends in the vaporization behavior of lighter actinide oxides. The heat of vaporization at 0°K would then be 429 ± 8 kcal/mole of Cm_2O_3. (auth)

36983 EFFECTS OF ADDITIVE CARBIDES ON THE STRENGTH OF WC-10 PERCENT Co ALLOY. Suzuki, Hisashi; Hayashi, Kozi (Tokyo Univ.). J. Jap. Inst. Metals; 34: 491-6 (May 1970). (In Japanese).

The strength of sintered WC-10% Co alloys containing 0 to 80% additive carbides such as tantalum, niobium, and titanium carbides, was studied in relation to their microstructures. The strength vs carbide content curves for various alloy systems were divided into three or four regions showing each characteristic structure according to the carbide contents. However, it was found that the shape or the strength level of the curve varied markedly even in the same alloy system, with varying sintered particle size of WC and additive carbides(s.s.phase), or with varying dimension as well as grain size of the carbide-agglomerate formed when the alloys contained a large amount of carbide. The effects of additive carbides on the strength of the alloys were

understood from the following three characteristic factors of carbides: the effectiveness on the inhibition of recrystallization of WC, the inherent property such as the strength or interfacial energy, and the dimensional factor of sintered additive carbides. The third factor was naturally related to the tendency of the grain growth or agglomeration, and to the surface to surface spacing of carbides, i.e., the particle size and the volume fraction before sintering. As a result, a certain WC/TiC/TaC triple carbide was shown to be the most favorable additive carbide, because the strength decrease in WC–Co alloy due to the addition of the carbide was minimized compared with the other carbides. (auth)

36984 THERMAL ANNEALING OF IRRADIATED LITHIUM HYDRIDE. II. A PROPOSED MECHANISM. Leider, H. R. (Univ. of California, Livermore). J. Phys. Chem. Solids; 31: 1221-4(Jun 1970).

Radiation causes considerable internal decomposition of lithium hydride, ultimately resulting in gross swelling and formation of bubbles of hydrogen and particles of metallic lithium. When irradiated LiH is heated, stored energy is evolved as the free lithium and hydrogen back-react to form LiH. A mechanism is proposed that describes the back-reaction as proceeding by H_2 molecules redissolving in the lattice, and then migrating to Li particles, where recombination occurs. An expression is developed that relates the size and the concentration of the hydrogen bubbles to the temperature characterizing the release of the stored energy. The data are shown to be consistent with this model. (auth) (UK)

Structure and Phase Studies

36985 (KFK-1131) STRUCTURAL ANALYSIS OF CERMETS. Jesse, Andreas (comp.) (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Material- und Festkoerperforschung). Jan 1970. 78p. (In German). Dep. CFSTI (U. S. Sales Only).

A collection of published papers dealing with the structure analysis of cermets is presented. A summarizing article gives some examples of new methods used in the investigation of the structure and indicates the lines of future development. (auth)

36986 (RT/MET-(70)1) MICROSCOPIC EXAMINATION OF SINTERED UO_2. De Matteis, M. V.; Fizzotti, C. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1969. 25p. (In Italian). Dep. CFSTI (U. S. Sales Only).

The results obtained during the examination of UO_2 pellets with optical and electron microscopes are described. Anomalous structures which were observed and the reason for their formation are shown and discussed. (auth)

36987 (UCRL-50886) INVESTIGATIONS AT HIGH TEMPERATURES: CONDENSED-PHASE EQUILIBRIA AND VAPORIZATION STUDIES WITH A MASS SPECTROMETER. Bedford, Ray G. (California Univ., Livermore. Lawrence Radiation Lab.). Jun 1970. 113p. Dep. CFSTI.

Thesis.

The Eu–Eu_2O_3 system was studied in detail, with the compositions and melting points of the stable phases being determined. Equilibria between the europium oxides and the Eu–Pt system were investigated at 1500°C, and the Sm–Sm_2O_3 and Yb–Yb_2O_3 systems were also studied. Ternary equilibria in the Eu–O–F and Sm–O–F systems were studied up to 1500°C for Eu^{2+}–Eu^{3+} and Sm^{+3}. A mass spectrometric investigation was carried out on the sublimation of Hf from a dilute alloy with Zr as a reference. The vaporization kinetics of GaN and the composition of the vapor species were studied. (D.L.C.)

36988 NEUTRON-INDUCED AUTORADIOGRAPHY OF LITHIUM SILICATE GLASSES. Wood, F. W. (Bureau of Mines, Albany, Oreg.); Robinson, A. H. J. Mater. Sci.; 5: 425-33 (May 1970).

Immiscibilities between silica and lithium disilicate were investigated. Alpha particles ejected from ^6Li atoms by thermal neutrons were used to autoradiograph surfaces representing diffusion-zone cross-sections. Etchant-enlarged alpha tracks in nitrocellulose disclosed the distribution of lithium. For autoradiography, procedural details were established, suitable operating conditions were selected, and the method was calibrated. For diffusion, adequate couples had to be prepared. Subsequent experiments indicated phase separations along as 885°C isotherm of the silica-lithium disilicate system. There was evidence of metastable compositions near 30, 25, 20, 16, 11, and 7 mole % of lithia in silica. These results have been given a very tentative interpretation: the first two compositions may correspond to metastable extensions of liquidus boundaries, projected through a eutectic point of the system. The third and sixth compositions are probably points on a liquid-liquid miscibility boundary, and the fourth and fifth compositions could be on an associated spinodal boundary. (auth) (UK)

36989 STUDY OF THE SYSTEM: SODIUM DIURANATE–VANADIUM HEMIPENTOXIDE. Lopez de Rodriguez, Elvira (Lille Univ.); Dion, Christian; Leroy, Jean-Marie. Compt. Rend., Ser. C; 270: 1015-17(16 Mar 1970). (In French).

Three new phases were identified and prepared by the reaction of sodium diuranate with vanadium hemipentoxide in the temperature range 400 to 1000°C. They are: $NaUO_2VO_4$, $Na(UO_2(VO_3)_3)$, and $Na_2U_2O_7 \cdot 7V_2O_5$. (auth)

36990 HIGHER HYDRIDES OF VANADIUM AND NIOBIUM. Reilly, J. J.; Wiswall, R. H. Jr. (Brookhaven National Lab., Upton, N. Y.). Inorg. Chem.; 9: 1678-82(Jul 1970).

Vanadium dihydride and niobium dihydride were prepared by the direct reaction of hydrogen with the metal. Attempts to prepare tantalum dihydride were unsuccessful. Pressure–composition isotherms were determined for the systems $VH\sim_{0.9}$ to $VH_{2.0}$ and $Nb\sim_{0.9}$ to $NbH_{2.0}$. Pertinent thermodynamic data were calculated for each system. The phase diagrams for the vanadium–hydrogen system and the niobium–hydrogen system were extended to a composition corresponding to MH_2. (auth)

36991 PHASE EQUILIBRIUM STUDIES IN THE SYSTEM CaO–Nb_2O_5–TiO_2. Jongejan, A.; Wilkins, A. L. (Dept. of Energy, Mines, and Resources, Ottawa). J. Less-Common Metals; 21: 225-53(Jul 1970).

Phase relationships in the system CaO–Nb_2O_5–TiO_2 have been studied. A Griffin–Telin hot-stage microscope was used for the determination of the liquidus temperatures, because the mixtures of compositions in this system did not form glasses, thus rendering the quench technique inapplicable. The liquidus fields of the following ternary compounds have been outlined, in addition to those of the binary compounds: (a) a compound having the composition $3CaO \cdot Nb_2O_5 \cdot 3TiO_2$, a pyrochlore structure and melting incongruently; its composition has been determined by subsolidus experiments; (b) a compound having a composition $8CaO \cdot 7Nb_2O_5 \cdot 6TiO_2$ that melted congruently and appeared to be metastable at subsolidus temperatures; its presence has been established from the shape of the liquidus surface; and (c), another ternary compound, having a composition $6CaO \cdot Nb_2O_5 \cdot 3TiO_2$ and melting congruently; its existence has also been established from the shape of the liquidus surface. Perovskite ($CaO \cdot TiO_2$) did not form solid solutions with any of the calcium niobates notwithstanding that the compound $4CaO \cdot Nb_2O_5$ and probably those niobates having a still higher lime content, have a perovskite type of structure. (auth)

36992 SURFACE FREE ANISOTROPY OF UO_2. Van Lierde, W. (SCK-CEN, Mol, Belgium). J. Mater. Sci.; 5: 527-31(Jun 1970).

A full review and discussion on the shape of isolated pores in UO_2 single crystals at high temperatures in connection with the anisotropy of surface free energy in crystalline solids is given. This work describes the production of spherical voids in a single crystal with diameters between 5 and 50μm generated by thermal decomposition of U_2N_3 precipitates. The equilibrium shape of the pores was reached by heating stoichiometric UO_2 for 200 hr at 1700°C under vacuum 10^{-6} torr or hyperstoichiometric UO_{2+x} for 200 hr at 1400°C at 5 torr oxygen. The statistical distribution of a/b for about 70 pores is given. The idealized equilibrium form with $a/b = 3.08 \pm 0.08$ is shown on a Wulff net. The calculated value of $\gamma 100/\gamma 111 = 1.19$ is compared with that of 1.152, obtained by Mackenzie and Moore by geometrical consideration of the number of atoms per unit area with 1, 2, 3, ... broken bonds, and that of 1.15 calculated by Wells. After oxidizing treatment of UO_{2+x} the pores became spherical and were all located at grain boundary intersections, due to the oxygen dissociation pressure, the rapid evaporation condensation processes and the introduction of interstitial oxygen atoms. The pronounced high temperature plasticity in UO_{2+x}, caused by the high mobility dislocations, resulted in polygonisation of the sample which became entirely polycrystalline. The increasing plasticity of UO_{2+x} with increasing x, due to the removal of anisotropy is considered. (auth) (UK)

36993 ORIENTED EUTECTIC MICROSTRUCTURES IN THE SYSTEM Al_2O_3/ZrO_2. Schmid, F.; Viechnicki, D. (Army Materials and Mechanics Research Center, Watertown, Mass.). J. Mater. Sci.; 5: 470-3(Jun 1970).

Oriented eutectic microstructures have been produced in the system Al_2O_3/ZrO_2 using a Bridgman-type crystal-growing furnace. Ingots consisted of elongated columnar grains or colonies. Inside the colonies a rod-type eutectic microstructure consisting of rods of ZrO_2 surrounded by an Al_2O_3 matrix was observed. The eutectic point was re-established at 63 mole% Al_2O_3/37.0 mole% ZrO_2 and 1870 ± 5°C. Al_2O_3 is the first phase to nucleate when eutectic growth occurs. (auth) (UK)

Radiation Effects

Refer also to abstracts 36946, 38481, and 38553.

36994 (BAW-3809-6) EXAMINATION OF STAINLESS-STEEL-CLAD ThO_2–UO_2 FUEL RODS AND ZIRCALOY-2 CAN AFTER OPERATION FOR 442 EFPD IN THE INDIAN POINT REACTOR. Final Report, Volume 1 of 3 Volumes. Baroch, C. J.; Harbinson, E. N.; Munim, A. V. (Babcock and Wilcox Co., Lynchburg, Va. Research and Development Div.). Aug 1969. Contract AT(30-1)-3809. 132p. Dep. CFSTI.

Detailed hot cell examinations were performed on 13 ThO_2–UO_2 fuel rods and one Zircaloy-2 can that were operated in Consolidated Edison's Indian Point Reactor for 442 effective full power days (EFPD). During this operating period, the fuel achieved peak burnups as high as 33,000 MWd/t, and the borated type 304 stainless steel cladding and the Zircaloy-2 can received peak fast neutron fluences (E > 1 MeV) of about 3×10^{21} nvt. All 13 fuel rods and the Zircaloy-2 can performed very satisfactorily and nothing indicated that these core components could not operate to a considerably higher exposure. The reactor exposure caused no major microstructural changes in the fuel. The lack of microstructural changes indicated that the centerline fuel temperature was probably less than 1600°C. The amount of fission gases released—1 to 2 %—was consistent with results from fuel temperatures in the 1600°C range. The ThO_2–UO_2 fuel operated to exposures of 33,000 MWd/t without introducing localized or general strains in the cladding. No ridging at the pellet interfaces was observed, even in the rod of highest exposure. Entire pellets could be easily removed from all rods regardless of the enrichment of the fuel or the burnup achieved. These fuel rods were fabricated with a diametral gap of 0.002 to 0.004 inch. The lack of pellet distortion and cladding strains and the fact that entire pellets could be removed from the cladding indicated that irradiation-induced fuel swelling was minimal. Urania fuels operated under similar conditions would show some increase in volume and possibly some ridging at pellet interfaces. Porosity was observed on the inside surface of the borated type 304 stainless steel cladding. This porosity took a variety of shapes, from fine, hairline cracks to spherical voids. The exact cause of the porosity was not determined, but it had no apparent ill effects on the performance of the fuel rod. Irradiation affected the tensile properties of the stainless steel cladding rather significantly. The ductility, as determined by uniform and total elongations, was quite low (generally less than 1% except at 70°F where it was about 5%) at all test temperatures and for the range of calculated fluences investigated (5×10^{20} to 3×10^{21} nvt). Annealing the cladding for 1 hour at 1000°C had little effect on the ductility of the cladding at all test temperatures, but annealing did reduce the yield and ultimate strengths to essentially the unirradiated values. From these results, it appeared that helium in sufficient quantities could reduce the ductility of austenitic stainless steels at all test temperatures. The in-reactor performance of the Zircaloy-2 can was identical to that predicted from out-of-pile tests. Although the oxide film was too thin to measure, the weight gain was estimated to be less than about 20 mg/dm² and the hydrogen content less than 40 ppM. The mechanical properties of the irradiated Zircaloy were similar to what one would predict from the available data. The uniform elongations of all specimens, regardless of the test temperature, were less than 1%. (auth)

36995 (CEA-N-1254) DENSIFICATION MECHANISMS UNDER IRRADIATION OF UO_2–PuO_2 MIXED OXIDE: EFFECTS ON FISSION GAS PRODUCTION. Mikailoff, Hubert; Bloch, Jacqueline; Conte, Madeleine (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Feb 1970. 32p. (In French). Dep. CFSTI (U. S. Sales Only).

A set of UO_2-15 percent PuO_2 small samples were irradiated during a few hours in the EL 3 reactor. The sintered pellet density was 98 percent and 87 percent of theoretical density. The porous materials were fabricated by two processes: direct sintering and chamotte process giving very different morphologies and sizes in porosity. The partial densification of the pellets mainly operates through two different mechanisms that are related to the initial porosity size (surface diffusion and sublimation). Finally the effect of these densification processes on the fission gas untrapping was shown. (auth) (France)

36996 (DP-Report-65) POST IRRADIATION DISSECTION AND EXAMINATION PROCEDURE FOR RISOE CORE REPLACEMENT RIG CAPSULE NO. 1. Project DRAGON. Barr, P. (Atomic Energy Establishment, Winfrith (England)). Nov 1961. 26p. Dep. CFSTI.

The procedure to be employed at Studsvik, Sweden for the post-irradiation examination of the core replacement rig capsule being irradiated at Risø, Denmark is discussed in relation to the apparatus specially constructed for the examinations. A short account of proposed operating conditions and of pre-irradiation measurements is also given. (auth)

36997 (ORNL-4520, pp 195-201) DEVELOPMENT OF URANIUM MONONITRIDE FUELS. (Oak Ridge National Lab., Tenn.).

From Fuels and materials development program quarterly progress report for period ending December 31, 1969.

The middle fuel pin of capsule UN-3 failed after 5800 hr of operation at a temperature of 1370°C at the surface of the cladding. Several short cracks were visible in the cladding over the fueled region of the pin. Visual examination and dye-penetrant tests established that the claddings of the top and bottom fueled pins remained sound during the irradiation test. Each of the three fuel pins was examined by gamma scan; no unusual characteristics were revealed. Measurement of the pin diameters with an opposed dial gage profilometer showed that each pin was reduced in diameter during irradiation testing; the range was from 0.001 in. for the bottom pin to 0.003 in. for the top pin. The nondestructive evaluation of these pins was completed, and the failed (middle) pin is being sectioned to investigate the cause of failure. (auth)

36998 (ORNL-4520, pp 245-53) FAST-NEUTRON IRRADIATION EFFECTS ON ELECTRICAL INSULATORS. (Oak Ridge National Lab., Tenn.).

From Fuels and materials development program quarterly progress report for period ending December 31, 1969.

Four commercial types of alumina were irradiated in the Engineering Test Reactor (ETR) at various temperatures from 400 to 1230°C and at various fluences from 1 to 7×10^{21} neutrons/cm² (>1 MeV). The irradiation assembly was identical to a short-term assembly that was irradiated to fluences from 0.4 to 3.1×10^{21} neutrons/cm². More specimens fractured in the long-term assembly than in the short-term assembly. For both assemblies, alumina of higher purity was damaged less than alumina of lesser purity. Specimens in the long-term assembly expanded in volume by about twice as much as those in the short-term irradiation. Part of the additional expansion is undoubtedly an increase in grain volume, which occurs almost linearly with increasing fluence above 10^{21} neutrons/cm², but some of it is probably a result of additional separation at grain boundaries caused by the increase in grain volume. (auth)

36999 (ORNL-4520, pp 259-64) FISSION-GAS RELEASE AND PHYSICAL PROPERTIES OF FUEL MATERIALS DURING IRRADIATION. (Oak Ridge National Lab., Tenn.).

From Fuels and materials development program quarterly progress report for period ending December 31, 1969.

Irradiation of a cylinder of large-grained UO_2 was terminated when it began cracking before temperatures reached the level for grain growth. Thermal data obtained from the specimen have not been processed because the mathematical methods first used did not give satisfactory results. New theories and processes developed to deal with the data appear very promising. Irradiation of sol-gel $(U,Pu)O_2$ microspheres has begun. (auth)

37000 (ORNL-4520, pp 265-94) DEVELOPMENT OF FUEL ELEMENT FABRICATION. (Oak Ridge National Lab., Tenn.).

From Fuels and materials development program quarterly progress report for period ending December 31, 1969.

Evaluation and design of an instrumented facility for irradiation of fuel plates in the High Flux Isotope Reactor (HFIR) is continuing. The experimental apparatus for testing flux and fission density was built and will be inserted next quarter. Postirradiation examination of fuel plates irradiated during fiscal year 1969 in the G-12 loop at the Engineering Test Reactor (ETR) provided further evidence that fabrication voids reduce the swelling of Al-base dispersions. Aluminum-base fuel plates produced by normal fabrication techniques and containing the burned grade of U_3O_8 had the largest amount of fabrication voids for a given volume fraction of fuel compound, and, hence, irradiation swelling was lower for this material than for the high-fired grade of U_3O_8 or UAl_x. A 50 wt % high-fired U_3O_8 plate was irradiated to a burnup of 2.24×10^{21} fissions/cm³ without failure. A study of the effect of variations in process parameters during the chemical cleaning of type 6061 Al on bonding during rolling was completed with encouraging results. However, extended use of the etching solution, extreme deviations in the etching temperature, use of cold water as a rinse, and extended storage of cleaned billets before rolling can deteriorate the bonding. Parametric studies of the deformation of UAl_x–Al and U_3O_8–Al dispersions are continuing. With respect to plate characteristics that influence irradiation performance, compacting pressure or compact density does not influence the amount of fabrication voids in the final composite plate, but the amount of cold rolling does affect the void content. The effects of variations in the size of fuel particles on the x-ray attenuation calibration curve are being studied. Investigations of the use of scattered and

fluorescent radiation for measuring the thickness of cladding are under way with ^{241}Am and ^{147}Pm radiation sources. The influence of the variables in the electron-beam welding process during the joining of simulated fuel plates to side plates is being evaluated statistically. (auth)

37001 (ORNL-4520, pp 295-7) BEHAVIOR OF REFRACTORY MATERIALS UNDER IRRADIATION. (Oak Ridge National Lab., Tenn.).

From Fuels and materials development program quarterly progress report for period ending December 31, 1969.

Irradiated specimens of refractory-metal carbides are being thermally annealed out-of-reactor to aid in defining damage mechanisms. Thermal annealing of displacements produced by fast neutrons in the carbides of Ti, Zr, Ta, Nb, and W was found to become significant at temperatures between 500 and 700°C. A high-temperature (1000°C) assembly and a low-temperature (150°C) assembly containing depleted UN, $U^{15}N$, and UN–UC (50-50 mole %) were constructed and inserted into the Engineering Test Reactor (ETR). The results of these irradiation experiments will determine the effect of He gas generated within nitride fuels through the $^{14}N(n,\alpha)^{11}B$ fast-neutron reaction. Preliminary design work was started on a comprehensive experiment in which B_4C will be irradiated in row 7 of the Experimental Breeder Reactor-II (EBR-II) to evaluate B_4C with different ratios of B:C and different void densities as a neutron absorber for control of reactivity in fast reactors. (auth)

37002 (ORNL-4586, pp 87-97) CHEMICAL SUPPORT FOR HIGH TEMPERATURE GAS-COOLED REACTORS. (Oak Ridge National Lab., Tenn.).

Studies on coated fuel particles, diffusion of actinides and fission products, coating failures, radiation effects, thermal diffusivity, fission product monitoring, and rotational collisional numbers of N_2, O_2, CO, and CO_2 are reported. (M.C.G.)

37003 (ORNL-4586, pp 118-25) SPECIAL RESEARCHES. (Oak Ridge National Lab., Tenn.).

Studies on neutron irradiation of carbides and alumina ceramics, gamma-irradiated polymers, radioinduced reaction of hydrocarbons, radiation-resistant insulators, and Plowshare activities are reported. (M.C.G.)

37004 (RT/MET-(69)3) A CONTRIBUTION TO THE STUDY OF COLUMNAR GRAINS AND CENTRAL VOID IN URANIUM OXIDE FUEL RODS. Cosoli, G.; Segre, G. J. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 5 May 1969. 23p. Dep. CFSTI (U. S. Sales Only).

In order to foresee the radial columnar grains and central void extension, in steady state conditions, as a function of the fuel and irradiation features, some irradiation experimental data are compared with the results of calculations. (auth)

37005 EFFECTS OF TEMPERATURE, γ IRRADIATION, AND CRYSTALLINITY ON DECAY PROCESS OF SURFACE ELECTRIC CHARGES ACROSS POLYETHYLENE FILM. Ieda, Masayuki; Takeuchi, Ryozo; Sawa, Goro (Nagoya Univ., Japan). Jap. J. Appl. Phys.; 9: 727-8(Jun 1970).

The 10-min decay rates of Ukalon LK50 polyethylene films under plus and minus polarity were determined at 20 and 50°C in three different ambient gases: N_2, 80% N_2–20% O_2, and CO_2. Gamma irradiation (5 Mrad) was found to increase the decay rate in N_2–O_2, particularly for the negative polarity. The increase in crystallinity in going from Ukalon LK50 to EX40 reduces the decay rate, particularly for the positive polarity. (D.L.C.)

37006 IRRADIATION CELL FOR THERMAL-NEUTRON FISSION OF SMALL SAMPLES ^{235}U. de Bruyne, Pierre. Int. J. Appl. Radiat. Isotop.; 21: 339-49(Jun 1970). (In French).

An indication of the importance of heat transfer, during the thermal-neutron fission of small samples 97.46 per cent-enriched uranium is given. Two 280 mg ^{235}U samples were irradiated in the UO_2 oxide powder form at 75 kW for 10 hr. Each sample was put into four quartz ampules, placed in aluminum containers and water cooled. Heat flow in the radial direction of the samples was calculated, assuming that: the resistance to heat transfer in the contact areas between solid materials was not negligible; and the thermal conductivities of the fuel, the quartz, the aluminum and the air, as well as the physical properties of the coolant (density, viscosity, specific heat) were constant and independent of temperature. The errors involved in this assumption depend on the severity of the temperature gradients and the dependence of the above properties on temperature. This method is accurate if they are linear functions of temperature. (auth) (UK)

Plastics and Other Materials

37007 (CEA-N-1236) ENERGY DISSIPATED IN THE CARBON DIOXIDE OF GRAPHITE REACTORS. Ribeiro, Fernando (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Mar 1970. 136p. (In French). Dep. CFSTI (U. S. Sales Only).

The excitation and ionization caused by fast neutrons and gamma radiations in the carbon dioxide of graphite reactors lead to a radiolytic corrosion of graphite by the activated CO_2. Two methods based on Monte-Carlo codes are developed in order to calculate the energy released in electronic form in graphite reactors. The results of these calculations are compared to the measurements performed on the Marius reactor (CEN/Cadarache). (auth) (France)

37008 DENSE CONCRETE AS A MATERIAL FOR MAKING PROTECTIONS AGAINST IONIZING RADIATION. Lipowski, L. (Technical Univ., Warsaw). Przegl. Budowlany; 40: 571-7 (1968). (In Polish).

The growing use of nuclear energy and the applications of radioactive isotopes create the need for radiation shields in research centers, atomic power stations, and in establishments where isotopes are used. Dense concrete shields, excellent as protection against radiation, feature adequate mechanical strength and are relatively cheap. The grades of dense concrete used for the building of radiation shields, physicochemical properties, and dense concrete design and production principles are discussed. A brief characterization of the local raw materials suitable as dense concrete fillers is given. (NSA of Poland)

37009 IRRADIATION OF DIELECTRIC TAPES AND THE LIKE. Johnston, Robert Buran; Porter, Charles Robert; Wilson, Dennis William (to General Electric Co.). British Patent 1,195,442. 17 Jun 1970. Priority date 11 Aug 1966, United States.

Methods of producing selectively etchable radiation damage tracks in dielectric tapes are described. A source of collimated fission fragments is incorporated in an apparatus which provides a means of defining the travel path of the tape through the zone subject to the collimated fission fragments. (J.R.D.)

PHYSICS (GENERAL)

Astrophysics and Cosmology

Refer also to abstract 37287

Cosmic Ray Exposure Ages

Refer also to abstract 36167.

37010 ZIRCONIUM AND HAFNIUM IN METEORITES BY ACTIVATION ANALYSIS. Ehmann, W. D.; Rebagay, T. V. (Univ. of Kentucky, Lexington). Geochim. Cosmochim. Acta; 34: 649-58(Jun 1970).

Zirconium and hafnium were determined in 28 chondrites and 7 achondrites by thermal and 14-MeV neutron activation analyses. The distribution pattern of these elements in the three major classes of chondrites showed that the order of atomic abundances for both elements relative to silicon ($Si = 10^6$ atoms) was: carbonaceous chondrites > ordinary chondrites > enstatite chondrites. Average atomic abundances of 13 atoms Zr($Si = 10^6$ atoms) and 0.19 atom Hf($Si = 10^6$ atoms) were established for the chondrites. The calcium-rich achondrites were observed to be enriched in these elements relative to the chondrites while an opposite trend was noted for the calcium-poor achondrites. The average Zr/Hf ratio on a weight basis for all the stony meteorites analyzed in this work was 43, a value which is in good agreement with that reported in the literature for the earth's crust. Based on this ratio, no significant fractionation of these elements between the earth and meteorites is implied. (auth) (UK)

Stars

Refer also to abstracts 37593 and 37596.

37011 (AD-695453) STATISTICS AT TWO POINTS OF THE GRAVITATIONAL OR ELECTRIC FIELD ARISING FROM A RANDOM DISTRIBUTION OF POINT MASSES OR CHARGES. Marcus, Allan H. (Johns Hopkins Univ., Baltimore, Md. Dept. of Statistics). Jul 1969. Contract Nonr-4010(09). 25p. (TR-120). CFSTI.

Suppose that a random vector field (gravitational, electric) can be represented as the superposition of isotropic disturbances arising from a homogeneous random distribution of points (masses, charges). The characteristic function of the joint distribution at two points in space is derived for an arbitrary force law. For an inverse-square force cutoff below a minimum distance ("stellar radius"), the pairwise longitudinal and transverse covariance functions in three dimensions are especially simple: linear functions of distance at distances less than a stellar diameter, inverse cubic functions of distance at greater distances. Integral representations are derived for pairwise correlations in two dimensions, and triple correlations in three dimensions, for an inverse-square force law cutoff below a stellar radius. (auth) (USGRDR)

37012 (AD-701085) DISTRIBUTION FUNCTIONS OF STAR CLUSTERS. Broderick, John (Brandeis Univ., Waltham, Mass. Dept. of Physics). Nov 1969. Contract F19628-69-C-0074. 65p. (AFCRL-70-48). CFSTI.

Two model globular clusters are constructed, each consistent with a given analytical surface density law known to fit actual star clusters well. One model is described by an isotropic distribution function (IDF) that depends on energy alone. The other model is described by the maximum energy distribution (MEDF) consistent with the given surface density. At small energies the IDF is exponential, while at high energies it linearly approaches a finite value at the cutoff energy. The coefficient in the exponential approaches a constant as the concentration of the cluster increases, explaining the failure of the model to fit spherical galaxies. Arguments in favor of the abrupt cutoff are advanced, based on the relaxation time being long compared with the circumgalactic orbital period, and on the change in the total escape energy as a cluster executes an elliptical circumgalactic orbit. It is shown that the truncated Maxwellian distribution in an MEDF is the distribution that is zero above the escape energy and constant below. For the given surface density the MEDF is computed by constructing a set of perturbing distribution functions that do not contribute to the density. These are added to the IDF in such a way as to maximize the entropy. Six perturbing functions were constructed and then used in finding the MEDF. (auth) (USGRDR)

37013 (CERN-70-8) MODERN PHYSICS FROM AN ELEMENTARY POINT OF VIEW. Lectures given in the Summer Vacation Programme, 1969. Weisskopf, V. F. (European Organization for Nuclear Research, Geneva (Switzerland)). 17 Mar 1970. 26p. Dep. CFSTI (U. S. Sales Only).

A discussion of various aspects of atomic and molecular physics is given. The theory starts with a single hydrogen atom and extends to solids. The various properties of cold and hot stars are also covered in a lecture. (M.O.W.)

37014 (N-70-12101) MASS LOSS BY HOT STARS. Lucy, L. B.; Solomon, P. M. (Columbia Univ., New York. Dept. of Astronomy). [1968]. 43p. (NASA-CR-106984). CFSTI.

A mechanism is proposed to explain the mass loss observed for luminous, hot stars. It is shown that the ultraviolet resonance lines of ions such as Si IV, C IV, N V, and S VI can give strongly negative effective gravities in the outer parts of the reversing layers of hot stars. It is argued that a static reversing layer is then no longer possible and that a continuous outflow of mass occurs. To calculate mass-loss rates resulting from this mechanism, formulation of the problem of steady-state, moving reversing layers is given. From numerical solutions of the equations of this problem, the mass-loss rate is found. The domain in the (logs of effective temperature and stellar surface gravity) plane where the greatest mass-loss rates are expected is also approximately determined and found to be roughly consistent with observation. Finally, the problem of the supersonic flow to large distances from the star is briefly discussed. (auth) (STAR)

37015 (N-70-17976) A COURSE IN ASTROPHYSICS AND STELLAR ASTRONOMY. VOLUME 2. PHYSICS OF STARS AND STELLAR SYSTEMS. Mikhailov, A. A.; (and others) (eds.). Translated from pp 1-705 of Kurs Astrofiziki i Zvezdnoi Astronomii, Izd. Nauka, Moscow, 1962. 665p. (NASA-TT-F-506; TT-68-50307). CFSTI.

Subject matter pertains to absolute stellar magnitude and stellar masses, binary stars, variables and novae, diffuse matter, theory of stellar atmospheres and gaseous nebulae, and stellar systems. (STAR)

37016 (N-70-21891) PULSATION ANALYSIS FOR STARS IN THERMAL IMBALANCE. Simon, Norman R. (National Aeronautics and Space Administration, New York. Goddard Inst. for Space Studies). [1969]. 31p. (NASA-TM-X-62825). CFSTI.

The effects of thermal imbalance on stellar pulsational stability are investigated by using the linear, quasi-adiabatic pulsation theory. Analyses of the standard model and of a white dwarf show that, for these cases, ordinary terms in the stability integrals greatly outweigh the extra terms considered here. The latter become more important when substantial ionization zones exist in the stellar matter. It is argued that the influence of thermal imbalance on pulsational stability should be quite small for stars crossing the H-R diagram in early post-main sequency evolution, and for cooling degenerate stars. On the other hand, during pre-main sequency contraction the thermal imbalance terms are more likely to be important, while for thermal runaways in shell-burning stars, these terms are almost certainly crucial. (auth) (STAR)

37017 (PB-183999) INTERMEDIATE-BAND AND NARROW-BAND PHOTOMETRY OF STARS. Final Report. McNamara, Delbert H.; Hansen, H. Kimball (Brigham Young Univ., Provo, Utah. Dept. of Physics). 1969. 6p. CFSTI.

The results obtained from a photometric study of selected objects made with a 24-inch telescope are summarized. The titles of the research programs are: intermediate-band photometry of RR Lyrae stars and dwarf Cepheids, metal abundance measurements of eclipsing binaries, photometry of globular star clusters, and photometry of the eclipsing stars RZ Scuti and ZZ Bootis. (USGRDR)

37018 CONVECTIVE ENERGY TRANSPORT IN STELLAR ATMOSPHERES. II. MODEL ATMOSPHERE CALCULATION. Ulrich, Roger K. (California Inst. of Tech., Pasadena). Astrophys. Space Sci.; 7: 183-200(May 1970).

The motion of convective cells in an environment which changes rapidly with depth is examined. In such an environment a cell may move through regions with different levels of ionization and with associated differences in heat capacity. The energy equation is cast in a manner which is independent of the history of these cells. The convective flux at a given level of the atmosphere is written as an average over an ensemble of cells originating at a range of other levels. A procedure for correcting the temperature gradient for these nonlocal effects is described and results for a model

solar atmosphere are given. The principal results are: (1) The rms velocity varies smoothly and is nonzero well into the photosphere (e.g., $v_{rms} = 1.4$ km/sec at $\tau = 0.2$); (2) Convective overshoot reduces the radiative flux to 60% and 90% of the total at $\tau = 2.5$ and 0.2 respectively; and (3) The interior adiabat of the convective envelope is less sensitive to the assumed value of the average cell size than in the usual treatment of convection. (auth)

37019 FURTHER OBSERVATIONS OF THE FILAMENTARY NEBULOSITY AROUND THE CETUS ARC (LOOP 2). Elliott, K. H.; Meaburn, J. (Univ. of Manchester, Eng.). Astrophys. Space Sci.; 7: 252-60(May 1970).

Previously some filamentary nebulosity was discovered around the outer edge of the Cetus Arc (Loop 2). Some further observations have now been made of this. To determine an upper limit to its proper motion it was photographed again with the Mount Palomar 48-inch Schmidt telescope. Also, to reveal the full extent of this nebulous region, more photographs have been added to the original mosaic and it has been photographed again with a wider field filter camera. No proper motion greater than 0.5"/year was detected. However, some further ridges of nebulosity were discovered. A shell model for Loop 2 based on this upper limit to the proper motion of the nebulosity and its similarity to the Cygnus Loop is presented. Some comments on the excitation mechanism of the nebulosity are also made. (auth)

37020 PHYSICAL FOUNDATIONS OF THE DYNAMICS OF STELLAR SYSTEMS. Tsitsin, F. A. Tr. Astrofiz. Inst., Akad. Nauk Kaz. SSR; 12: 3-16(1969). (In Russian).

The general statistical and physical assumptions of Stellar dynamics are considered. The necessity of using a one-valued determination of "volume" in the statistical theory of a discrete system (atomic–molecular, stellar, and so on) is considered. It is shown that in the statistical–dynamical system (atomic–molecular, stellar, the Boltzmann Universe, and so on) for the system's entropy S, $S_{max} - \overline{S} \gg \sqrt{(S-\overline{S})^2}$. Considering the fluctuations, a functional connection between entropy and the state-probability does not exist. (auth)

37021 PROBLEM OF DYNAMICS OF OPEN CLUSTERS. Chumak, O. V. Tr. Astrofiz. Inst., Akad. Nauk Kaz. SSR; 12: 75-81(1969). (In Russian).

The question of the possibility of formation of open clusters as a result of gravitational instability in the stellar gas is discussed. Some peculiarities of the structure and dynamics of these objects are considered. (auth)

37022 SLOW ROTATION OF Ap AND Am STARS. Monaghan, J. J. (Monash Univ., Victoria, Australia). Astron. Astrophys.; 6: 464-7(Jul 1970).

In a long-period highly eccentric binary, the axial rotation of the secondary is essentially unaffected until the envelope of the primary intersects the orbit of the secondary. Assuming that mass transfer is never fast enough to allow the envelope to adjust to the changing Roche potentials, the effect of the envelope, in turbulent convection, on the dynamics of the secondary is examined. It is shown that the axial rotation is reduced and the orbit becomes circular as the semi-major axis decreases. It is suggested that some slowly rotating Am and Ap stars owe their slow axial rotation to this type of process. (auth)

37023 OBSERVATIONS OF FAINT VARIABLE STARS NEAR THE NORTH GALACTIC POLE. Plaut, L. (Kapteyn Astronomical Lab., Groningen, Netherlands). Astron. Astrophys.; 6: 486-7(Jul 1970).

Magnitudes of 18 variable stars were determined from 46 pg and 10 pv plates taken by Borgman with the 122-cm Palomar Schmidt telescope. Earlier results by Kinman, Wirtanen, and Janes (1966) were confirmed. (auth)

37024 HOMOGENEOUS STELLAR MODELS. Jensen, J. O.; Joergensen, H. E. (University Observatory, Copenhagen). Astron. Astrophys.; 6: 488-90(Jul 1970).

New opacities have been published by Cox and Stewart. They are compared with those previously used in model computations and the influence on zero-age models is discussed. (auth)

37025 SHELL SOURCE BURNING STARS WITH HIGHLY CONDENSED CORES. Refsdal, S.; Weigert, A. (Univ. of Nebraska, Lincoln. Univ. of Oslo). Astron. Astrophys.; 6: 426-40(Jul 1970).

Simple analytical relations are derived, similar to the homology relations for homogeneous stars, which describe the behavior of shell-source burning models with highly condensed cores. Many features known from evolutionary calculations (and partly from observations) of such stars can be understood as coming essentially from the increase of the mass of the core. Changes of the radius of the core, of the radiation pressure, and of the chemical composition are also considered. For a comparison, sequences of numerically calculated equilibrium models are presented. They show that the analytical relations give, even quantitatively, good approximations to the numerical results. (auth)

37026 PRELIMINARY ORBIT OF THE VISUAL BINARY ADS 9975 = A 1642 = JDS 2417. Dommanget, J.; van Dessel, E.L. (Royal Observatory, Belgium). Astron. Astrophys.; 6: 423-5 (Jul 1970).

Orbital elements and physical characteristics of the visual binary ADS 9975 were calculated, adopting a change of quadrant for the observations later than ≈1950. This assumption is based on the possible variability of one of the components. (auth)

37027 ATMOSPHERIC STRUCTURE AND CHEMICAL COMPOSITION OF MAIN-SEQUENCE K-STARS. Strohbach, P. (Univ., Kiel). Astron. Astrophys.; 6: 385-405(Jul 1970). (In German).

Differential fine analyses relative to the Sun were performed for HD 192310 (K2V, weak Ca II emission), HD 156026 (K5V, strong Ca II emission), 61 Cyg A (K5V, strong Ca II emission), HD 190404 (K2V, no Ca II emission), and HD 219134 (K3V, medium Ca II emission). (W.D.M.)

37028 THE HELIUM ABUNDANCE IN POPULATION I STARS. Popper, Daniel M. (Univ. of California, Los Angeles); Joergensen, Henning E.; Morton, Donald C.; Leckrone, David S. Astrophys. J.; 161: L57-61(Jul 1970).

The positions of thirteen main-sequence eclipsing binaries in a mass–radius diagram are employed to identify seven of them as unevolved. Comparison of these seven systems with predictions of homogeneous models in the mass–luminosity plane leads to a helium/hydrogen ratio of 0.12 by number of atoms. Estimates of various sources of uncertainty indicate that this number is unlikely to lie outside the range 0.09 to 0.14. A brief comparison with other determinations is given. (auth)

37029 He I λ10830 IN GASEOUS NEBULAE. Persson, S. E. (Carnegie Inst. of Washington, D. C.). Astrophys. J.; 161: L51-5(Jul 1970).

It is suggested that the relative weakness of the He I λ10830 line in galactic and planetary nebulae results from absorption of the resonantly trapped photons by solid particles. (auth)

37030 CONTRIBUTION OF ELECTRON–ELECTRON INVERSE BREMSSTRAHLUNG TO STELLAR OPACITY. Cattani, M.; Fernandes, N. C.; Osada, J. (Univ. of Sao Paulo, Brazil). Astrophys. J.; 161: 135-7(Jul 1970).

The contribution to stellar opacity from electron–electron inverse bremsstrahlung, which is usually regarded as a minor effect, is calculated explicitly. It is shown that this effect is fairly large for the case of high-density and high-temperature stars. (auth)

37031 NUCLEAR PARTITION FUNCTIONS FOR STELLAR REACTION RATES. Bahcall, Neta A. (California Inst. of Tech., Pasadena); Fowler, William A. Astrophys. J.; 161: 119-34 (Jul 1970).

Nuclear partition functions were calculated as a function of temperature for nuclei with mass numbers $A \leq 40$. These functions are important for determining reaction rates when contributions from nuclear excited states are included. Simple approximate expressions for the partition functions were also derived. (auth)

37032 SLOWLY ROTATING RELATIVISTIC STARS. IV. ROTATIONAL ENERGY AND MOMENT OF INERTIA FOR STARS IN DIFFERENTIAL ROTATION. Hartle, James B. (Univ. of California, Santa Barbara). Astrophys. J.; 161: 111-18(Jul 1970).

The mass–energy of a slowly and differentially rotating general-relativistic star is shown to differ from that of a nonrotating star with the same number of baryons by an amount $M_{rot} = \frac{1}{2}\int \Omega dJ$. Here, Ω is the angular velocity and dJ the angular momentum of a fluid element in the star. In the case of uniform rotation this reduces to $M_{rot} = \frac{1}{2}I\Omega^2$, where I = (total angular momentum)/(rigid angular velocity) is the relativistic generalization of moment of inertia. These relations are accurate to second order in the angular velocity but involve only quantities which can be calculated from the first-order equations of structure. Explicit forms of these relations are given, and upper and lower bounds on the rotational mass–energy are derived. (auth)

37033 ON THE DEPENDENCE OF T_e UPON QUANTITY VERSUS QUALITY OF THE RADIATION FIELD IN A STELLAR ATMOSPHERE. Gebbie, K. B.; Thomas, R. N. (Joint Inst. for Lab. Astrophysics, Boulder, Colo.). Astrophys. J.; 161: 229-41 (Jul 1970).

A simple algebraic expression is derived for $T_e(\tau)$ that demonstrates as a function of collisions how and where the control of T_e shifts from the quantity to the quality of the radiation field in a

stellar atmosphere. Explicit formulae are obtained for the gray case and it is shown that mechanical heating and nongray processes can be treated algebraically as perturbations. The size and effect of these processes are illustrated by applying them to the Sun in the region $10^{-2} > \tau_5 > 10^{-5}$. (auth)

37034 ATMOSPHERES OF CLASSICAL CEPHEID VARIABLES. Keller, C. F. (Los Alamos Scientific Lab., N. Mex.); Mutschlecner, J. P. Astrophys. J.; 161: 217-28 (Jul 1970).

Calculations were made for a hydrodynamic model of a 11.5d Cepheid. Radiative transport was treated by the equation of transfer in optically thin zones, and the radiation was divided into ten frequency intervals. Lower boundary conditions, taken from a previous deep-envelope model, were time-dependent luminosity and velocity. Results indicate that no significant changes in the luminosity or velocity curves were introduced by the present refinements as compared with previous models that used a Rosseland mean opacity over all frequencies. In a second portion of the study hydrostatic, constant-flux atmospheres were computed with parameters g_{eff} and T_{eff} taken from hydrodynamic models at selected phases. The structures of these atmospheres compare well with the hydrodynamic models, and B − V colors predicted by the atmospheres and hydrodynamic models also show favorable agreement. The relation T_{eff} versus B − V shows good agreement with selected observations when blanketing corrections are included. It is concluded that hydrostatic atmospheres appropriately fitted can adequately predict observable properties for Cepheid models of this type. (auth)

37035 NARROW-BAND AND BROAD-BAND PHOTOMETRY OF RED STARS. III. SOUTHERN GIANTS. Eggen, O. J.; Stokes, N. R. (Australian National Univ., Canberra). Astrophys. J.; 161: 199-216 (Jul 1970).

Broad-band (UBV) and narrow-band (102, 65, 62) photometry is given for 593 bright southern K- and M-type stars. Luminosities based on calibrations derived previously and space motions are derived for 527 stars. (auth)

37036 THE MANAGANESE STAR IOTA CORONAE BOREALIS. Ross, J. E.; Aller, L. H. (Univ. of California, Los Angeles). Astrophys. J.; 161: 189-97 (Jul 1970).

An abundance analysis of the manganese star ι Coronae Borealis is carried out in detail by making use of a model atmosphere with $\theta_e = 0.458$, log[g] = 3.7, N(He)/N(H) = 0.12. The energy distribution and Hγ profile are reproduced by this model to within the observational error. Furthermore, the abundances derived from neutral and ionized species of Mg, Cr, Mn, and Fe indicate that this is the correct model. The analysis shows that the light metals have normal abundance, the iron group might be slightly overabundant, and manganese and the heavy elements are about 25 times overabundant. (auth)

37037 THE MANGANESE STAR PHI HERCULIS. Zimmermann, R. E.; Aller, L. H.; Ross, J. E. (Univ. of California, Los Angeles). Astrophys. J.; 161: 179-88 (Jul 1970).

A detailed abundance analysis of the manganese star φ Her is carried out; the analysis employs a model atmosphere with T_e = 12500°K, log g = 4.0, N(He)/N(H) = 0.12, and with a microturbulent velocity of 2.5 km sec^{-1}. The observed spectral energy distribution and Hγ profile are satisfactorily reproduced by the model. The abundances derived from neutral and ionized iron are not the same; this may be due partly to bad f-values and partly to the effect of line blanketing on the temperature distribution in the outer layers of the atmosphere. The analysis shows that the light metals have normal abundance, as do iron and cobalt, while scandium, titanium, and the remaining heavy elements are 10 to 1000 times overabundant with respect to adopted solar values. Inaccuracies in the f-values cannot remove these abundance differences, since the same system of f-values was used in both the Sun and the star. (auth)

37038 RATIO OF TITANIUM TO ZIRCONIUM IN LATE-TYPE STARS. Boesgaard, Ann Merchant (Univ. of Hawaii, Honolulu). Astrophys. J.; 161: 163-78 (Jul 1970).

High-dispersion (4 to 15 Å mm^{-1}) spectrograms of thirty-six K-M stars, five Ba II stars, six MS stars, and nine S stars have been analyzed by a curve-of-growth technique to yield the atomic-abundance ratio of Ti to Zr. The correction arising from formation of the molecular oxide is considered. The Ti/Zr ratio for the K and M giants is similar to the solar value. In the Ba II and S stars, this ratio is 3 to 30 times lower than in the normal stars; the average value is about 6 times less. The average for the MS stars is intermediate between the normal stars and the Ba II and S stars. The abundance results are compared with those of other investigators to examine the evolutionary interrelationships of the various types of red giants. The discussion is in the context of nucleosynthesis. (auth)

37039 VERY YOUNG CLUSTER WITH A MODERATE METAL DEFICIENCY. Eggen, Olin J. (Australian National Univ., Canberra). Astrophys. J.; 161: 159-62 (Jul 1970).

From proper motions and (UBV) photometry twenty stars, ranging from B5 to G0, were found to be members of the high-latitude young cluster associated with ζ Sculptoris. The reddening is E (B − V) = +0.02 mag, and the cluster is 240 pc above the plane at galactic latitude −79°. The color−luminosity array shows the main-sequence gaps associated with other young clusters; however, unlike the other known young clusters, the ultraviolet excess of 0.10 mag, compared with the Hyades stars, indicates a moderate metal deficiency. (auth)

37040 METAL-POOR STARS. II. INITIAL HORIZONTAL-BRANCH MODELS. Rood, Robert T. (Massachusetts Inst. of Tech., Cambridge). Astrophys. J.; 161: 145-57 (Jul 1970).

Grids of initial horizontal-branch models obtained with Cox−Stewart opacities are presented for six compositions. These models are less luminous than those obtained with earlier approximations to the opacity, so the result is that the predicted RR Lyrae luminosities are not inconsistent with those estimated observationally for field RR Lyrae stars. Estimates of cluster ages made by using these models will be 3 to 6 billion years larger than earlier estimates. (auth)

37041 A QUESTION OF ENTROPY. Strittmatter, P. A. (Inst. of Theoretical Astronomy, Cambridge, Eng.); Faulkner, J.; Robertson, J. W.; Faulkner, D. J. Astrophys. J.; 161: 369-73 (Jul 1970).

The form of energy conservation equation to be used in calculations of stellar evolution is discussed. Claims by Kutter and Savedoff that previous formulations were incorrect in omitting chemical potential terms are refuted. (auth)

37042 ANALYSIS OF THE CO BANDS IN ARCTURUS. Greene, Thomas F. (Boeing Co., Seattle). Astrophys. J.; 161: 365-7 (Jul 1970).

Recent measures of the equivalent widths of the ^{12}CO and ^{13}CO rotational lines in Arcturus (α Boo) are analyzed. It is concluded that the ^{12}CO features are readily understood on the basis of the known carbon and oxygen abundances but that the $^{12}C/^{13}C$ ratio, as indicated by red ^{13}CN 2-0 rotational lines, exceeds 10. Hence, a contradiction seems to exist between the ^{13}CO and ^{13}CN data. (auth)

37043 THE RATE OF MASS EXCHANGE IN DQ HERCULIS. Starrfield, Sumner G. (Yale Univ. Observatory, New Haven). Astrophys. J.; 161: 361-3 (Jul 1970).

A rate of mass accretion of $10^{-8\pm1}$ $M_\odot$ $year^{-1}$ is derived for the white-dwarf component of DQ Her. The increase in orbital period of Nather and Warner is then used to derive a rate of mass loss from the secondary of 7×10^{-8} $M_\odot$ $year^{-1}$. (auth)

37044 SOME POSSIBLE COMPONENTS OF CIRCUMSTELLAR GRAIN MATERIAL. Fix, John D. (Univ. of Iowa, Iowa City). Astrophys. J.; 161: 359-60 (Jul 1970).

Dissociative-equilibrium calculations show that ZrO_2, TiO_2, and VO may become supersaturated in the atmospheres of cool, oxygen-rich stars. It is suggested that an investigation of the nucleation and growth of particles of these materials could shed light on the origin and nature of circumstellar grains. (auth)

37045 THE PRESSURE BROADENING OF Na I λ5889 BY HIGH-TEMPERATURE NEUTRAL HELIUM. Burgess, D. D. (Harvard Coll. Observatory, Cambridge, Mass.); Grindlay, J. E. Astrophys. J.; 161: 343-9 (Jul 1970).

A technique is described for producing usable quantities of high-temperature neutral helium and eventually of dissociated but neutral hydrogen, which would thus allow direct measurements of damping constants for lines of astrophysical interest. Results are presented on the broadening of Na I λ5889 by neutral helium. (auth)

37046 EXPERIMENTAL TRANSITION PROBABILITIES FOR SOME OXYGEN LINES OF ASTROPHYSICAL INTEREST. Pinnington, E. H.; Kernahan, J. A.; Lin, C. C. (Univ. of Alberta, Edmonton). Astrophys. J.; 161: 339-42 (Jul 1970).

The beam-foil technique was used to measure radiative lifetimes for transitions due to oxygen ions. From these values were calculated transition probabilities for seventeen O II lines found in the spectra of B-type stars and for eight O III lines found in the spectra of O-type and Wolf-Rayet stars, all lying in the range 3250 to 4650 Å. The data are compared with other recent experimental and theoretical values. (auth)

37047 ELECTRON-IMPACT EXCITATION AND IONIZATION CROSS SECTIONS AND RATES FOR HYDROGEN. Sampson, Douglas H. (Pennsylvania State Univ., University Park); Golden, Lawrence B. Astrophys. J.; 161: 321-37 (Jul 1970).

By using a semiempirical approach, a simple, general representation for excitation and ionization cross-sections and rates for atomic hydrogen is obtained which gives results in approximate agreement (to within ~25%) with all the well-established theoretical and experimental data. The corresponding collisional-excitation rates are larger than those proposed by most other workers, especially for transitions other than n = n + 1. (auth)

37048 NONSIMILARITY LINEAR WAVE CLOUD COLLAPSE SOLUTIONS. Wright, Alan E. (York Univ., Toronto). Mon. Notic. Roy. Astron. Soc.; 148: 455-61(1970).

A set of analytical nonsimilarity solutions are presented for the equations of gravito-gas dynamics with thermal gas pressure and radiative cooling. It is suggested that, as well as being of interest in themselves, they afford a particularly stringent method of testing numerical gas cloud collapse computer programs for computational inaccuracies and instabilities. (auth) (UK)

37049 CALCIUM EMISSION INTENSITIES AS INDICATORS OF STELLAR AGE. Wilson, Olin; Woolley, Richard (California Inst. of Tech., Pasadena). Mon. Notic. Roy. Astron. Soc.; 148: 463-75(1970).

Fresh data are presented concerning the calcium emission intensities of 325 main-sequence late-type stars estimated by one of the authors (O.W.). These are compared with parameters of the galactic orbits of the stars according to methods worked out at R.G.O. A very clear correlation is found between the calcium emission intensities and the eccentricities and box angles (inclinations) of the orbits. This reinforces the view that main-sequence stars with strong calcium reversals are young stars, and have near circular orbits with low inclinations to the galactic plane; while stars with feeble emissions are old stars which have, statistically, high eccentricities and high inclinations to the galactic plane. (auth) (UK)

37050 CHEMICAL COMPOSITION OF TWELVE LATE F DWARFS. Powell, A. L. T. (Royal Greenwich Observatory, Sussex, Eng.). Mon. Notic. Roy. Astron. Soc.; 148: 477-88 (1970).

The chemical composition of 12 Late F dwarfs was determined by differential curve-of-growth analysis using blue coudé plates. For each star fourteen elemental abundances were determined from ninety-two spectral lines. In addition the electron pressure, damping parameter, and total Doppler velocity were found spectroscopically. The analysis was performed by a series of computer programs. Compared with the Sun, the iron-to-hydrogen ratio varied from −0.35 to 0.18 dex and most other elements followed the abundance of iron. Manganese was found to be overdeficient when iron was itself deficient. The correlation found with stellar kinematics and ages substantiates previous work in this field. (auth) (UK)

37051 LITHIUM IN F- AND G-TYPE STARS. I. ISOTOPE ABUNDANCES. Feast, M. W. (Radcliffe Observatory, Pretoria). Mon. Notic. Roy. Astron. Soc.; 148: 489-99(1970).

The wavelength of the lithium 6708 A line was determined from 65 spectra at 13.7 A mm^{-1} for 12 lithium-rich F and G type stars. ^7Li is always the predominant isotope. The results are consistent with an upper limit of about 0.5 for R′, the $^6Li/^7Li$ ratio. There is some suggestion of two groups of stars one with R′ ~ 0 and another with R′ ~ ⅓. Stars of particular interest, all of which have R′ ~ 0 are (1) the two subgiant components of the visual binary γ CrA (2) the highly evolved G8 subgiant ω Sgr (3) the slightly evolved, metal-deficient, subdwarf γ Pav. ζ Dor (F8, slightly above the main sequence) appears to have a significant amount of ^6Li (R′ ~ 0.5). It also has a very active chromosphere as shown by H and K emission and λ5876 (He I, D_3) absorption. A review of the available data indicates that the few stars with high R′ (~0.5) are all subgiants. Radial velocity determinations for these and some other stars are given. (auth) (UK)

37052 ENERGY TRANSFER IN THE CONVECTIVE ENVELOPE OF A ROTATING STAR AND THE SOLAR DIFFERENTIAL ROTATION. Osaki, Yoji (Columbia Univ., New York). Mon. Notic. Roy. Astron. Soc.; 148: 391-406(1970).

Energy transport in the convective envelope of a rotating star is studied under the assumption that large-scale circulation currents may be neglected. The problem then reduces to a second-order differential equation for the perturbed entropy with the exponent of the gravity-darkening law on the surface as an eigenvalue. This equation is solved when all the energy is transported by convection and a criterion obtained for the validity of Lucy's (1966) gravity-darkening law. If rotation reduces the efficiency of convective energy transport, small deviations from barotropy result. The possibility then arises that the differential rotation of the Sun is driven by this baroclinic stratification. An equatorial acceleration of the right order is obtained if rotation reduces the efficiency of convective energy transport in the direction perpendicular to the axis of rotation. (auth) (UK)

37053 THREE WOLF–RAYET BINARIES. Ganesh, K. S.; Bappu M. K. V. Kodaikanal Observ. Bull., Ser A; No. 185: 104-19(1968).

Radial velocities and line profiles were studied of the three Wolf–Rayet binaries HD 193928, HD 186943, and HD 211853. HD 193928: A new orbit was determined from radial velocity measures of He II 4686. The orbital elements were as follows: γ axis = +60 km/sec, K = 147 km/sec, e = 0.12, ω = 51°, f(m) = 4.62 m. The N IV 4058 velocities can be represented by the He II 4686 velocity curve displaced in phase by 0.1P. A displacement of 185 km/sec in the gamma axis suffices to fit the 4686-A curve onto the N V 4603 velocities. Line profile variations with phase of the emission lines are described. HD 186943: A revised period of 9.5594 days was derived for this system. Orbital elements were derived using velocity curves He II 4686, N V 4603, and N IV 4058. The orbital elements derived from He II 4686 were as follows: γ axis = +107 km/sec, K = 212 km/sec, e = 0.04, ω = 151°, γ(N IV 4058) = +70 km/sec, γ(N V 4603) = +30 km/sec. HD 211853: Preliminary elements were derived from velocity curves of He II 4686, N V 4603, and N IV 4058. These were as follows: γ(He II 4686 = +15 km/sec, γ(N V 4603) = +35.0 km/sec, γ(N IV 4058) = −120 km/sec, e(He II 4686 = 0.12, k (He II 4686) = 220 km/sec, f(m)(He II 4686) = 7.25. The observations are discussed in terms of some of the current ideas on the nature of the Wolf–Rayet phenomenon. (Indian Sci. Abstr.)

Quasi-Stellar, Radio, and X-Ray Sources

Refer also to abstract 37917.

37054 (AD–684098) X-RAY SPECTRA OF SEVERAL DISCRETE COSMIC SOURCES. Meekins, J. F.; Henry, R. C.; Fritz, G.; Friedman, H.; Byram, E. T. (Hulbert (E. O.) Center for Space Research, Washington, D. C.). 1968. 44p. CFSTI.

Spectra of Scorpius XR-1, Cygnus XR-1, and Cygnus XR-2 were derived for the 1.5- to 13-keV photon energy range from proportional counter measurements made on September 8, 1967. (auth) (USGRDR)

37055 (AD–684294) ROCKET OBSERVATIONS OF BRIGHT CELESTIAL INFRARED SOURCES. Feldman, P. D. (Hulbert (E. O.) Center for Space Research, Washington, D. C. Johns Hopkins Univ., Baltimore, Md. Dept. of Physics); McNutt, D. P.; Shivanandan, K. (Hulbert (E. O.) Center for Space Research, Washington, D. C.). Sep 1968. 15p. CFSTI.

Several celestial sources were detected in the 20- to 30-μ spectral region by a rocket-borne telescope. The average flux is of the order of 4×10^{-14} W/cm². It appears that these sources are extragalactic and have luminosities comparable with the quasars. (auth) (USGRDR)

37056 (AD–698206) QUASAR MODELS AND NEBULAE. Status Report, January 1–October 31, 1969. Gold, T. (Cornell Univ., Ithaca, N. Y. Center for Radiophysics and Space Research). Nov 1969. Contract N00014-67-A-0077-0007. 8p. (CRSR–355). CFSTI.

A status report is given on work in the areas of pulsating radio sources, quasars, and radio galaxies. (USGRDR)

37057 (AD–701073) A MODEL OF EXTRAGALACTIC RADIO SOURCES. Mills, David M.; Sturrock, Peter A. (Stanford Univ., Calif. Inst. for Plasma Research). Nov 1969. Contracts N00014-67-A-0112-0006; F44620-69-C-0008. 23p. (SU-IPR–347). CFSTI.

A model is proposed for the compact bright radio sources ejected from radio galaxies and quasars. It is shown that the model gives good agreement with the characteristic brightness distribution and polarization behavior of these sources. Specific application is made to the radio source Cygnus A. (auth) (USGRDR)

37058 (N–70–17456) THE CRAB NEBULA ANCIENT HISTORY AND RECENT DISCOVERIES. Rossi, B. B. (Massachusetts Inst. of Tech., Cambridge. Center for Space Research). Oct 1969. 39p. (NASA-CR–107845; CSR-P–69-27). CFSTI.

A model is developed that pictures the Crab Nebula as a thin plasma cloud containing a weak magnetic field, with a fast rotating strongly magnetized neutron star at its center. The magnetization of the star does not have axial symmetry, so that the rotation gives rise to time-varying electromagnetic fields capable of accelerating electrons. These electrons remain within the corotating magnetosphere of the neutron star, where they give rise to fan-shaped corotating beams of electromagnetic radiation. Subsequently, they diffuse into the surrounding cloud, where they acquire further energy by a Fermi-type stochastic process. Synchrotron emission by these electrons in the weak

magnetic field of the cloud gives rise to the steady flux of radiation. (auth) (STAR)

37059 PULSARS AS SOURCES OF COSMIC RAYS. Wayland, J. R. (Univ. of Maryland, College Park). Astrophys. Space Sci.; 7: 201-10(May 1970).

The observed characteristics of pulsars were considered with respect to how they would affect cosmic rays if pulsars are the sources of cosmic radiation. Particular attention was given to the various time properties of suggested acceleration mechanisms. They are divided into three general cases: (a) constant with time, (b) sudden injections at discrete times, (c) slowly varying with time. In each case the possibility of either a monoenergetic or a power law injection spectrum with respect to energy was taken into account. (auth)

37060 RADIAL VELOCITIES AND DISTANCES OF GALACTIC H II REGIONS. Georgelin, Y. P.; Georgelin, Y. M. (Observatoires, Marseille). Astron. Astrophys.; 6: 349-63(Jul 1970). (In French).

174 radial velocities and distances of optical H II regions are given. (auth)

37061 SURVEY OF H 109α RECOMBINATION LINE EMISSION IN GALACTIC H II REGIONS OF THE SOUTHERN SKY. Wilson, T.L. (Massachusetts Inst. of Tech., Cambridge); Mezger, P. G.; Gardner, F. F.; Milne, D. K. Astron. Astrophys.; 6: 364-84(Jul 1970).

A survey of hydrogen 109 α-recombination lines was carried out during 1968, using the 210-foot radio telescope of the CSIRO Division of Radiophysics together with the NRAO 6-cm cooled parametric amplifier. One hundred and forty-nine galactic sources and one extragalactic source were observed. Line emission was detected in a total of 130 of the sources in the survey. Kinematic distances, using the Schmidt model, were calculated for those sources exhibiting the H 109 α line. In addition, intrinsic source parameters, such as the mass of ionized hydrogen and the average electron density, were calculated, assuming the source is a uniform, spherical region whose distance is given from kinematics. The percentage number of nonthermal sources was compared with that of the NRAO–MIT survey. (auth)

37062 ELECTRON TEMPERATURE IN H II REGIONS. Louise, R. (Observatoires, Marseille). Astron. Astrophys.; 6: 460-3(Jul 1970).

New results obtained by the method using widths at half-intensity of Hα and [N II] lines are presented. The observations were done with a high-resolution Fabry–Pérot interferometer at the 80- and 120-cm telescopes of the Haute Provence Observatory. From these observations the electron temperature and the turbulence in five H II regions were found. Using the spectral type given by Georgelin (1969) for the exciting stars, results (including the previously published ones) are compared with Hjellming's theoretical predictions (1968). (auth)

37063 NEW APPROACH TO APERTURE SYNTHESIS PROCESSING. Burns, W. R.; Yao, Stanton S. (National Radio Astronomy Observatory, Green Bank, W. Va.). Astron. Astrophys.; 6: 481-5(Jul 1970).

Aperture synthesis makes use of an interferometer to sample the complex visibility function. One then transforms the result to obtain an estimate of the brightness distribution. In principle the process is straightforward. In practice, however, a complete measurement of the visibility function is not always available. Instead measurements exist only along a series of ellipses which are defined by the available instrumental baselines and source declination. One is thus faced with estimating the source brightness distribution based on the poorly sampled visibility function. A technique has been investigated in which the available measurements are used to interpolate over the missing regions. The brightness distribution is then obtained from the interpolated visibility function. This technique is described and example results are shown. The results are compared to those obtained without the use of the interpolation. (auth)

37064 PULSARS: IS A NOD AS GOOD AS A WINK. Axford, W. I.; Johnson, H. E.; Mendis, D. A.; Yeh, T. Comments Astrophys. Space Phys.; 11: 53-8(Mar-Apr 1970).

The suggestion that pulsars might be rotating and precessing neutron stars has recently been published by Vila (Nature, 224: 157(1968)). This possibility has also been considered and ultimately discarded for a variety of reasons by Pacini and his colleagues, by Urey, and by the authors. Some of the objections that can be raised against the suggestion are described, and it is concluded that it is probably untenable despite some apparently attractive features. (W.D.M.)

37065 POSSIBLE PULSED GAMMA-RAY EMISSION FROM THE CRAB NEBULA PULSAR. Charman, W. N. (Atomic Energy Research Establishment, Harwell, Eng.); White, G. M. Nature (London); 226: 1233(27 Jun 1970).

Reference is made to Vasseur et al. (Nature 226: 534 (1970)) who suggested from their results that the Crab pulsar NP 0532 emits a flux of ~10^{-5} photons/cm^2/sec. at >50 MeV. These results were based on balloon-borne spark chamber observations and, if confirmed, would be of great significance not only for the Crab pulsar but also for the whole field of gamma-ray astronomy, where the evidence for point sources of gamma rays is marginal. The present authors discuss the data and consider that the statistical weight is much weaker than suggested. The discussion includes the effect of pulsar position, the angular resolution of the equipment, and the pulsar period. It is hoped that further analysis of the complete range of balloon observations will provide a firmer basis for the claims. (UK)

37066 PULSED GAMMA RAYS FROM THE CRAB NEBULA? Delvaille, J. P.; McBreen, B. (Cornell Univ., Ithaca, N. Y.). Nature (London); 226: 1233-4(27 Jun 1970).

Reference is made to Vasseur et al. (Nature 226: 534 (1970)) who reported the possible detection of pulsed gamma emission above 50 MeV from the Crab Nebula. The data were obtained from two balloon flights and in their analysis these authors stated that the probability of the observed pulsed effects on each flight had a 2% chance of resulting from random fluctuations, and that the overall chance probability for both flights was 0.04%. The present authors point out that the method of analysis leads to a much higher probability for these effects to arise from random fluctuations, and conclude that the observed pulsations may easily be accounted for as being due to random fluctuations. Further evidence is needed before it can be concluded that pulsed gamma emission above 50 MeV has been detected from the Crab Nebula. (UK)

37067 LINEAR POLARISATION OF MP 0628 AND ITS EMISSION AT METRE WAVELENGTHS. Vitkevich, V. V.; Shitov, Y. P. (Lebedev Physical Inst., Moscow). Nature (London); 226: 1235-6(27 Jun 1970).

This pulsar was studied at metre wavelengths using the E–W arm of the broadband cross-type radiotelescope at Pushchino; linear polarization was detected. A total bandwidth of 840 kHz was covered, with 12 channels each of 70 kHz bandwidth, spaced by 70 kHz, so that fine structure could be looked for in the spectrum. The studies were made in November–December 1969, at frequencies of 105 and 86 MHz, and the dispersion appeared to be 34.4 pc/cm^3. Pulse amplitudes were notably different at different frequencies. Analysis of the data indicated that the effects are caused by Faraday rotation and not scintillation phenomena due to irregularities of the interstellar plasma, and evidence is given for this conclusion. Some parameters of MP 0628 are reported. The degree of linear polarization is rather high. The rotation angle appears to be 550 rad (at 86 MHz), so that the rotation measure is 45 rad/m^2, giving a mean longitudinal magnetic field of 1.6×10^{-6} G towards MP 0628. Similar observations were made on CP 0328. (UK)

37068 SOFT X-RAYS FROM THE CYGNUS LOOP. Grader, R. J.; Hill, R. W.; Stoering, J. P. (Univ. of California, Livermore). Astrophys. J.; 161: L45-50(Jul 1970).

An extended source of soft x-rays was detected in Cygnus. Emission is largely between 0.2 and 1 keV. The location and angular size indicate the source to be the Cygnus Loop supernova remnant. (auth)

37069 CARBON MONOXIDE IN THE ORION NEBULA. Wilson, R. W.; Jefferts, K. B.; Penzias, A. A. (Bell Telephone Labs., Inc., Holmdel, N. J.). Astrophys. J.; 161: L43-4(Jul 1970).

Intense 2.6-mm line radiation was found from nine galactic sources which is attributed to carbon monoxide. (auth)

37070 $n \rightarrow n+1$ TRANSITION OF ATOMIC HYDROGEN INDUCED BY HYDROGEN-ATOM IMPACT. Flannery, M. R. (Smithsonian Astrophysical Observatory, Cambridge, Mass.). Astrophys. J.; 161: L41-2(Jul 1970).

Rates for the collisional-excitation process H(1s) + H(n) $\rightarrow$ H(1s) + H(n + 1), where n is the principal quantum number in the range $15 \leq n \leq 200$, are presented at various thermal energies. These rates are important for the interpretation of the anomalous recombination lines observed in H I regions. (auth)

37071 FORBIDDEN-LINE EMISSION FROM HOT H I REGIONS. Silk, Joseph (Princeton Univ. Observatory, N. J.). Astrophys. J.; 161: L37-40(Jul 1970).

Diffuse emission in the lines [O I] λ6300 and [N I] λ5200 from a hot (~10^4 °K), low-density intercloud medium is estimated, and is compared with night-airglow observations. Detection of the [O I] line by Peimbert in the nuclei of M51 and M81 yields an es-

timate of the flux of low-energy cosmic rays or soft x rays in the central regions of these galaxies. (auth)

37072 PHOTOELECTRIC SPECTROPHOTOMETRY OF 4C 05.34. Oke, J. B. (California Inst. of Tech., Pasadena). Astrophys. J.; 161: L17-20 (Jul 1970).

The multichannel photoelectric spectrometer was used to obtain the absolute spectral-energy distribution in the quasi-stellar radio source 4C 05.34 from λ3220 to λ9000. The strengths of the emission lines, in terms of both equivalent width and absolute intensity, the spectral index, and the absolute flux are typical of quasi-stellar sources. Lyman β is observed, and there is a drop of intensity by a factor of 2 at the Lyman limit. From the data it is inferred that the optical depth is of the order of unity in the Lyman continuum and is approximately 3 at the center of Lβ. (auth)

37073 DETECTION OF X-RAY EMISSION FROM 3C 273 AND NGC 5128. Bowyer, C. Stuart (Univ. of California, Berkeley); Lampton, Michael; Mack, John; de Mendonca, Fernando. Astrophys. J.; 161: L1-L7 (Jul 1970).

Well-collimated proportional counters sensitive to 1 to 10-keV x rays were flown on an attitude-controlled Aerobee 150 rocket and detected discrete sources at the positions of the extragalactic objects 3C 273, NGC 5128 (Cen A), and M87. The x-ray emission from Cen A is confined within 2° of the optical galaxy. The x-ray flux of Cen A falls below the extrapolated radio spectrum. (auth)

37074 THE DETECTION OF 21-CENTIMETER HYDROGEN ABSORPTION ARISING FROM WITHIN THE RADIO GALAXY CENTAURUS A. Roberts, Morton S. (National Radio Astronomy Observatory, Green Bank, W. Va.). Astrophys. J.; 161: L9-12 (Jul 1970).

Hydrogen-line absorption at 21 cm originating from within or near the radio galaxy NGC 5128 (Cen A) was detected. This is the first such detection. The absorption profile has a midpoint radial velocity of 563 km sec^{-1}. This may be compared with 540 km sec^{-1}, the average of four emission-line optical measurements of the systemic velocity. At least five distinct components can be recognized in the profile. Meaningful H I optical depths cannot be calculated, since no information on the geometry of the absorbing clouds is available from these measurements. (auth)

37075 OH EXCITED-STATE EMISSIONS FROM W75 B AND W3 OH. Rydbeck, O. E. H.; Kollberg, E.; Elldér, J. (Chalmers Univ. of Tech., Goteborg). Astrophys. J.; 161: L25-35 (Jul 1970).

Strongly varying 6035-MHz emission from the F = 3 → 3 transition of the $^2\Pi_{\frac{1}{2}}$, J = ½ state of OH was detected in W75 B with the Onsala 84-foot, maser-equipped telescope. These variations appear to be well correlated with simultaneously observed temporal variations in the 1667-MHz ground-state radiation. The 6035-MHz emission is split, possibly by rotation of the emitting object or by a magnetic field, into two almost circularly polarized components. None of the remaining three lines of this state were found in W75 B. Detailed Onsala observations of the F = 3 → 3 and F = 2 → 2 lines from W3 OH have shown that they are also polarized much like the W75 B emissions but lack detectable temporal variations. An effort has been made to relate the W3 OH excited-state emissions to some of the ground-state components previously resolved by VLBI methods. The Onsala group has looked for the 6-GHz excited-state emission in several other sources including W75 A, but so far with negative results. Because of the strong intensity variations found in W75 B, negative results must be reviewed with some caution. (auth)

37076 COLLECTIVE MODES OF PLASMA SURROUNDING A COLLAPSED STAR. Coppi, B.; Ferrari, A. (Massachusetts Inst. of Tech., Cambridge). Astrophys. J.; 161: L65-9 (Jul 1970).

The relationship between "equilibrium" configuration of the plasma surrounding a spinning collapsed star and nonthermal mechanisms for particle and radiation emission is pointed out. On this basis models for pulsar and x-ray emission can be proposed. (auth)

37077 LIMITATION ON SYNCHROTRON MODELS WITH SMALL PITCH ANGLES. O'Dell, Stephen L.; Sartori, L. (Massachusetts Inst. of Tech., Cambridge). Astrophys. J.; 161: L63-4 (Jul 1970).

A restriction on possible synchrotron models for nonthermal spectra is obtained. (auth)

37078 THERMAL INSTABILITY OF A MODEL HYDROGEN PLASMA. Defouw, Richard J. (Carnegie Institution of Washington, D. C.). Astrophys. J.; 161: 55-65 (Jul 1970).

The thermal stability of a hydrogen plasma is analyzed with the aid of a simple model atom which possesses a continuum of unbound states but only one bound level (the ground state). If ionization is collisional and recombination is radiative, the model plasma is thermally unstable if and only if its kinetic temperature exceeds 17500°K. Although this plasma emits only free-bound radiation (the free-free emission is neglected), the instability is caused by the same ionization effects which lead to instability in plasmas emitting line radiation. The instability criterion and the growth rate (if it is not too large) are not affected by the presence of a uniform magnetic field unless the motions are constrained to be perpendicular to the field. The applicability of equations of steady-state ionization to calculations of thermal instability is examined. (auth)

37079 INTERNAL MOTIONS IN GALACTIC AND EXTRAGALACTIC H II REGIONS. Smith, Malcolm G. (Kitt Peak National Observatory, Tucson, Ariz.); Weedman, Daniel W. Astrophys. J.; 161: 33-40 (Jul 1970).

Emission-line profiles were observed for the total Hα emission from nine H(II) regions in the galaxies M101 and M33. A pressure-scanned, Fabry-Pérot interferometer was used in the observations. The most probable velocities of internal motions are found to range from 19 to 34 km sec^{-1}. Slitless spectra are presented to illustrate the structure of the three giant H(II) regions observed in M33. Radial velocities for five H(II) regions in the Galaxy were derived at numerous positions within the regions, and the average velocities and rms dispersions in velocity are compared with the results of other observers. (auth)

37080 THE POLARIZATION OF VARIABLE RADIO SOURCES AT 8 GHz. II. INTERPRETATION. Aller, Hugh D. (Univ. of Michigan, Ann Arbor). Astrophys. J.; 161: 19-31 (Jul 1970).

The variations in polarization of extragalactic radio sources observed at 8 GHz are compared with the predictions of a model of the expanding-source type and found to have a number of characteristics in common. The rapid variations in polarization are interpreted as being produced primarily by the decrease in radio optical thickness of the source with time. The amplitudes of the changes in polarization indicate that the magnetic fields in these objects must be relatively homogeneous over large regions. The apparent low degrees of polarization generally derived for the variable components of these sources are believed to be due to the depolarization effect of synchrotron self-absorption. The absence of appreciable Faraday depolarization and the fact that the Razin-Tsytovich effect is not observed in the variable components provides an upper limit on the density of thermal electrons present in these variable components. This upper limit is several orders of magnitude less than the density estimates obtained from optical emission-line data. The derived upper limit to the amount of nonrelativistic material ejected in each outburst is of the order of 0.5 $M_\odot$. In the case of 3C 279, data on polarization position angle over a wide range of wavelengths allow an upper limit of 10 cm^{-3} to be placed on the density of thermal electrons surrounding the variable component. The large disparity between radio and optical estimates of the density of ionized gas appears to require either that this gas be confined to "blobs" or filaments, or that it form a disklike distribution which does not completely envelop the central, variable component of the source. (auth)

37081 THE POLARIZATION OF VARIABLE RADIO SOURCES AT 8 GHz. I. THE OBSERVATIONS. Aller, Hugh D. (Univ. of Michigan, Ann Arbor). Astrophys. J.; 161: 1-18 (Jul 1970).

A program to monitor the linear polarization of variable radio sources at 8 GHz has been carried out at the University of Michigan since mid-1965. H(II) regions and extended nonthermal sources were observed frequently in order to determine the instrumental polarization and to check the stability of the equipment. Five sources exhibited significant changes in polarization: 3C 120, 3C 273, 3C 279, 3C 345, and 3C 454.3; three sources, 3C 84, NRAO 150, and 3C 446 probably have variable polarizations. Changes in both the degree of polarization and the position angle of the polarization have been observed in these sources with time scales as short as 1 week. The most rapid variations in polarization usually occurred when the total flux density was increasing or had reached a maximum value. The amplitudes of the variations in polarized flux density were as great as 10% of the amplitudes of the variations in total flux density. Two sources, 3C 279 and 3C 454.3, exhibited large changes in polarized flux density during periods when the total flux densities were not changing significantly. (auth)

37082 LEVEL POPULATIONS OF HYDROGEN IN GASEOUS NEBULAE. Brocklehurst, M. (University Coll., London). Mon. Notic. Roy. Astron. Soc.; 148: 417-34 (1970).

The departures, b_n, of the populations of excited levels of hydrogen, from those under conditions of thermodynamic equilibrium, are calculated. Collisions between all levels, n and n', are allowed for. Solutions are obtained using the matrix condensation technique of Burgess and Summers (1969). Tables of b_n and $\log_{10}$

(d ln b_n/d_n) are given for $n \leq 300$ and for a wide range of electron temperatures and densities. The results differ considerably from those obtained allowing only for collisional transitions in which the change in principal quantum number is small. (auth) (UK)

Solar Phenomena

Refer also to abstracts 37018, 37052, 37215, 37375–37379, and 37381–37384.

37083 (AD–691093) SOLAR RADIOASTRONOMY PROGRAMS AND RESEARCHES, 1966–1968. Abrami, Alberto; Sedmak, Giorgio; Cimarosti, Argeo (Osservatorio Astronomico, Trieste (Italy)). 1 Apr 1969. Contract AF61(052)-926. 63p. (AFCRL–69-306). CFSTI.

Observations of the solar radio flux density were undertaken in March 1966 and pursued in the following years with the aim of studying the radio outbursts correlated with chromospheric flares. A ten-meter parabolic reflector was planned and constructed for the observations of flux density and polarization in ten frequency bands between 200 and 1000 Mc. The work done until Feb. 28, 1969 is related to the measures at the single frequency of 239 Mc, in one polarization only, but with low- and high-resolution recording devices. The usefulness of the high-resolution techniques for the studies of the microstructures of the radio outbursts are pointed out that present, sometimes, a very interesting periodic fluctuation, stationary over limited time intervals. (auth)

37084 (AD–694034) SOLAR SOURCE OF INTERPLANETARY MAGNETIC FIELDS. Wilcox, John M.; Severny, A.; Colburn, David S. (California Univ., Berkeley. Space Sciences Lab. Crimean Astrophysical Observatory, Simferopol (Ukrainian SSR). 28 Aug 1969. Contract Nonr-3656(26). 11p. CFSTI.

The mean magnetic field of the Sun (seen as a star) during the interval March–June 1968 has an almost complete agreement with the polarity of the interplanetary magnetic field observed near the Earth. This agreement could exist only if the solar source of the interplanetary field was part of a field pattern that was ordered over an appreciable portion of the solar disk. The result is consistent with a previously derived solar sector pattern in the weak, large-scale photospheric field in which the boundary between two solar sectors is at almost the same longitude independent of latitude over a range of at least 40° N to 40° S latitude. Comparison of the contribution of sunspot magnetic fields with the mean solar field indicates that the sunspot fields do not have a direct influence on the interplanetary field. (auth) (USGRDR)

37085 (AD–694105) STUDY OF THE RADIO FREQUENCY SPECTRUM OF THE SUN. Final Report, January 1, 1966–March 31, 1969. Maxwell, Alan (Harvard Radio Astronomy Station, Fort Davis, Tex.). Apr 1969. Contract AF19(628)-5744. 15p. (AFCRL–69-310). CFSTI.

Research on radio bursts from the Sun is reported. The following subjects are discussed: radio interference at Fort Davis, Texas; new electronics equipment and receivers at the Harvard Radio Astronomy Station at Fort Davis; solar radio observations and theoretical work; and research on the nature of solar activity. Also included is a list, with abstracts, of relevant articles published as a result of the contract. (USGRDR)

37086 (AD–698264) SOLAR EMISSION AND ACTIVITY IN THE FREQUENCY REGION 18 TO 36 GIGACYCLES. El Raey, Mohammed; Silver, S.; Welch, W. J. (California Univ., Berkeley. Space Sciences Lab.). Dec 1969. Contract Nonr-222(54). 13p. CFSTI.

The spectral distribution of solar radiation and the characteristics of solar activity were studied intensively and may be considered well known in the megacycle region of the spectrum. Attention has turned recently to higher frequencies and it is being recognized that there is much to be learned about the Sun by studying the emission and activity in the centimeter- and millimeter-wave region. The paper is a report of recent observations made over the frequency band 18 to 36 GHz and the correlation of the observations with optical data on sunspots, plages, and flares. One set of observations was carried out at the time of the flare event of April 25, 1969. (auth) (USGRDR)

37087 (AD–699549) CONSTRUCTING SOLAR FLARE EVENTS BY COMPUTER. Environmental Research Papers. Fischer, Hans J. E.; Hendl, Richard G. (Air Force Cambridge Research Labs., L. G. Hanscom Field, Mass.). Nov 1969. 48p. (AFCRL-ERP–307; AFCRL–69-480). CFSTI.

A computer program was developed which processes and groups individual observations of solar flares which describe the same feature. From each group of observations a consolidated description of the flare "event" is produced. The report details the methods by which these groups are formed and the subsequent consolidated descriptions achieved. (auth) (USGRDR)

37088 (AD–699936) SOFT SOLAR X-RAY BURST CHARACTERISTICS. Drake, Jerry F. (Iowa Univ., Iowa City. Dept. of Physics and Astronomy). Jan 1970. Contract Nonr-1509(06). 172p. CFSTI.

Thesis.

Solar x rays in the wavelength range 2 to 12 A (1 to 6 keV) were monitored by detectors on the satellites Explorer 33 (since July 1966) and Explorer 35 (since July 1967). These x-ray data were converted into absolute flux values by computer for the above data. In this large quantity of data, thousands of x-ray bursts were observed. A means was devised to examine the burst component of the flux by computer. A total of 4028 bursts were identified in this manner for the period July 1966 to September 1968. This burst sample was examined for possible parameters by which to classify bursts. In a comparison with other flare data, the relationship between H alpha flare occurrence and x-ray burst occurrence was examined. The distribution of soft x-ray bursts with heliographic longitude was determined in order to test the nonthermal, directional emission proposal. A comparison was made with harder (photon energy greater than 6 keV) solar x-ray bursts to study the temporal and amplitude relationship of the two phenomena. (USGRDR)

37089 (AD–701716) CORRELATION OF X-RAY RADIATION (2–12 A) WITH MICROWAVE RADIATION (10.7 cm) FROM THE NON-FLARING SUN. Progress Report. Gibson, Jean; Van Allen, James A. (Iowa Univ., Iowa City. Dept. of Physics and Astronomy). Jan 1970. Contracts Nonr-1509(06); N00014-68-A-0196-0003; NAS5-9076. 68p. CFSTI.

The present paper utilizes (a) an extended, homogeneous body of of solar x-ray observations (2 to 12 A) from Explorer 33 and Explorer 35 for 734 days during the period July 1, 1966 to December 25, 1968 and (b) the 10.7 cm (2800 MHz) daily solar radio flux values of the Algonquin Radio Observatory. The specific purposes of the work were to establish the relationship between daily average values of the x-ray and radio fluxes from the whole disc of the nonflaring sun and to consider the significance of the relationship. (USGRDR)

37090 (N–70-18783) NOTE ON MODELS OF THE PROPAGATION OF SOLAR FLARE PLASMA THROUGH INTERPLANETARY SPACE. Hirshberg, J.; Spreiter, John R. (Stanford Univ., Calif. Dept. of Applied Mechanics). 1969. Contract NAS2-5355. 21p. (NASA-CR–108138). CFSTI.

Theoretical treatments of the propagation of a solar-flare disturbance in interplanetary space discuss a blast wave expanding from the Sun as a center of symmetry. However, recent observations indicate that the solar-flare piston often is not expanding in a spherically symmetric manner. Some possible causes of the lack of spherical symmetry, assuming the blast models are essentially correct are examined. It is found that failures of different basic assumptions underlying the blast model lead to distinctly different shapes for the propagating flare body. The shapes are sufficiently different so that observations should soon be available that will distinguish between the models. (auth) (STAR)

37091 (N–70-22889) SOLAR PROTON MONITORING SYSTEM. Adams, G. W.; Megill, L. R. (Space Disturbances Lab., Boulder, Colo.). Aug 1969. 47p. (NASA-CR–109319; ESSA-TR-ERL–119-SDL–10). CFSTI.

A real-time solar-proton monitoring system with ground-based sensors located in Alaska and other parts of the United States, Greenland, and Canada is discussed. A computer in Anchorage, Alaska, interrogates the sensors, processes the data, and transmits the information via teletype to the Solar Forecast Center in Boulder, Colorado. The physics of the system is described, i.e., the characteristics of the events (PCA's, auroras, SID's, REP's, and solar noise bursts), how the sensors (riometers, VLF phase and amplitude, forward scatter, neutron monitors, and magnetometers) respond to these events, how these characteristics are programmed to detect the different events, and how the sensor readings are used to obtain information about solar protons. (auth) (STAR)

37092 (N–70-23526) A STUDY OF THE EFFECT OF THE ELECTROMAGNETIC INTERACTION BETWEEN THE MOON AND THE SOLAR WIND. Schwartz, K. (American Nucleonics Corp., Glendale, Calif.). Dec 1969. Contract NAS2-5153. 102p. (NASA-CR–73433; ANC–63-R-12). CFSTI.

The electromagnetic interaction of the solar wind with the Moon was investigated. These investigations cover the dc and time-dependent interactions that were initiated to provide a theoretical framework by which the experimental data obtained

from the Explorer 35 magnetometer and the Apollo 12 ALSEP magnetometer can be interpreted and correlated. The dc interaction has also been proposed as a possible mechanism for providing an intense heating phase during the initial development of the solar system. An alternative model for the T Tauri environment is proposed. This alternative model tends to have higher driving fields, and higher momentum and energy flux during the period when intense planetary heating can occur. (auth) (STAR)

37093 RADIOIZLUCHENIE SOLNTSA. SBORNIK 1. (Solar Radioemission. Collection 1). Grigench, G. A. (ed.). Leningrad; Izdatel'stvo Leningradskogo Universiteta (1969). 104p.

This collection of articles by different authors contains results of investigations of solar radio emission related to the problem Sun–Earth and to a solar survey made by the Physical Institute of Leningrad State University. Results of studies of the structure and characteristics of the solar atmosphere responsible for radio emission in the centimeter and decimeter wave ranges are given. Certain manifestations of solar activity in the radio range and possibilities for their prognostication are discussed. Methods of observation related to this problem were worked out, and certain results of such observations are included. Characteristics of solar radio emission needed for its use as a cosmic source of known intensity and known direction are described. (tr-auth)

37094 SOURCES OF TYPE III SOLAR BURSTS OBSERVED AT 169 MHz WITH THE NANCAY RADIOHELIOGRAPH. Bougeret, J.-L.; Caroubalos, C.; Mercier, C.; Pick, M. (Observatory, Meudon, France). Astron. Astrophys.; 6: 406-14(Jul 1970).

Results of observations of Type III solar bursts with the Nançay radioheliograph—space resolution 34′, time resolution used 10^{-1}s—are presented. Forty-five bursts were studied and classified in different categories: "stationary", "slipping", "double". Measurements of the diameter, lifetime, and position are given. An asymmetric halo is observed in most cases. The interpretation is briefly discussed. (auth)

37095 EXPERIMENTAL AND THEORETICAL ELECTRON IMPACT BROADENING OF SOME Mg II AND Ca II LINES OF ASTROPHYSICAL INTEREST. Chapelle, J. (Faculte des Sciences, Orleans, France); Sahal-Brechot, S. Astron. Astrophys.; 6: 415-22(Jul 1970).

The electron impact profiles of the Mg II (3s–3p, 2802.7 Å and 3d–4f, 4481.3 Å) and Ca II (4s–4p, 3933.7 Å and 3d–4p, 8542 Å) lines were measured in an argon plasma jet and were calculated within the impact and semi-classical approximations. The agreement between experiments and calculations is good. (auth)

37096 INTERPLANETARY SHOCK WAVES. II. SHOCK STRUCTURE. Sonett, C. P. Comments Astrophys. Space Phys.; 11: 59-65(Mar-Apr 1970).

Some of the gross features of interplanetary shock waves and the accompanying body of driver gas were discussed in Part I. Experiment verifies that for this purpose it is sufficient to employ aerodynamic analogy, but this still leaves open the question of how the shock layer can form in a collision-free medium. An essential requirement is some form of dissipation, the definition of which can be attempted using bulk transport parameters or, alternatively, a microscopic description. (W.D.M.)

37097 SOLAR RADIATION FROM 1 TO 100 A. Landini, M.; Fossi, B. C. Monsignori (Arcetri Astrophysical Observatory, Florence). Astron. Astrophys.; 6: 468-75(Jul 1970).

The emission from the solar corona in the spectral region 1 to 100 Å is computed for temperatures ranging from 10^6 to 10^7 °K and emission measure $\int n_e^2 dV = 10^{49}$ cm^{-3}. The ionization equilibrium calculations of Jordan are used; they include processes of autoionization and dielectronic recombination. Both continuum and line emission are considered. Continuum radiation is produced by processes of bremsstrahlung and recombination, mainly due to C (V), C (VI), O (VII), O (VIII), and N (VII), which affects the region below 30 Å. Line emission from ions of elements C, N, O, Ne, Mg, Si, S, Ca, and Fe in the isoelectric sequences from H to Cl, are considered. The spectral distribution is given for T_e = 1, 2, 4, 6, 8, 10 × 10^6 °K, comparison between observed and computed flux of several lines is made and the temperature of $T_e \simeq 1.5 \times 10^6$ °K for the quiet corona is obtained. Temperatures greater than 7×10^6 °K are necessary to explain observations of several lines below 8 Å during flare activity. (auth)

37098 BALLOON OBSERVATIONS IN THE SUBMILLIMETER REGION: AN ABSOLUTE MEASUREMENT OF THE BRIGHTNESS OF THE SUN AND THE TRANSPARENCY OF THE STRATOSPHERE ABOVE 25 KM. Gay, J. (Observatoire, Meudon. France). Astron. Astrophys.; 6: 327-48(Jul 1970).

Several experiments have been successfully launched by a group involved in infrared space studies at the Meudon Observatory. The present description deals with solar flights aimed at absolute spectrophotometry of the Sun's radiation in the wavelength range from 50 to 200 μ. The purpose of the measurements is to obtain a better determination of the solar brightness temperature in the transition zone between the photosphere and the chromosphere. The results indicate temperatures lying between the values given by the BCA model and by the recent HSRA model, in the 100- to 200-μ range. The measured temperature is 4600° K ± 400° K. At shorter wavelengths, the temperature seems to increase to more than 5000° K. The medium-resolution spectra (0.5 cm^{-1}), using the Sun as a source, show submillimetric absorption lines. Because the balloon was at different altitudes (28.4 and 25 km) when the spectra were made, one can draw certain conclusions concerning the stratospheric water content. The quantity of precipitable water vapor is measured, and found to be much smaller than previous results by other authors. The stratospheric transmission is, therefore, excellent; this opens a wide field of investigation for astronomical studies, using the stabilized gondola developed by the National Center for Space Studies (CNES). (auth)

37099 EVIDENCE FOR A CORONAL MAGNETIC BOTTLE AT 10 SOLAR RADII. Schatten, Kenneth H. (Goddard Space Flight Center, Greenbelt, Md.). Solar Phys.; 12: 484-91(Jun 1970).

The Faraday rotation of a radio source (Pioneer 6) occulted by the solar corona has been measured by Levy et al., (1969). During the course of these measurements, three large-scale transient phenomena were observed. These events were preceded by subflares and class 1 flares. These transient events are interpreted as evidence for a coronal magnetic bottle at 10 $R_\odot$. The velocity of propagation for the disturbance is set at 200 km/sec; the dimension of the region, 10 $R_\odot$; field strength at 10 $R_\odot$, 0.02 G; particle density, 2.0×10^4/cm^3; Alfvén speed, 320 km/sec. From the nature of the observations and the lack of related effects from similar flares on the interplanetary sector pattern observed at 1 AU, it is suggested that such coronal magnetic bottles expand to perhaps 10 to 30 $R_\odot$ and then contract to a few solar radii. Such a phenomena is evidence for an expansion of the corona with a sub-Alfvénic velocity. It is further suggested that such magnetic bottles may be important in the storage and diffusion of solar generated cosmic-ray particles. (auth)

37100 FLARE-ASSOCIATED CORONAL EXPANSION PHENOMENA. Bruzek, Anton (Fraunhofer Institut, Freiburg i. B.); Demastus, Howard L. Solar Phys.; 12: 447-57(Jun 1970).

Two classes of coronal expansion phenomena were studied in Sacramento Peak coronal movies: slow, slightly decelerated expansion phenomena (v ~ 10 – ~ 2 km/sec) and fast accelerated, quasi-exploding arches (v ~ 10 – > 100 km/sec). The various phenomena were found to be associated with flares in different ways: The slow expansions were long-lived post-flare phenomena initiated by the flare; the accelerated expanding arches were either (a) arches expanding prior to and apparently exploding at flare onset, or (b) arches apparently emerging from the flare (probably in its initial phase) and rapidly expanding and exploding, or (c) the expansion and disruption of (originally stable) coronal arches during occurrence of a distant flare. These expansions may be considered as evidence for corresponding flare associated changes in the coronal magnetic field. (auth)

37101 ACCELERATION AND MOTION OF IONS IN CORONA AND SOLAR WIND. Geiss, Johannes (Manned Spacecraft Center, Houston, Tex. Univ., Bern); Hirt, Peter; Leutwyler, Heinrich. Solar Phys.; 12: 458-83(Jun 1970).

Assuming a stationary, radial, spherically symmetric solar wind and a radial magnetic field direction in the vicinity of the Sun, an equation of motion for ions heavier than protons in the solar wind is derived. The general properties of this equation are discussed and the results of numerical integrations are given. These results are based on the assumption of Maxwellian velocity distribution functions for electrons, protons, and ions, but the effects of first order deviations from such distributions are also presented and discussed. It is shown that dynamical friction, i.e., momentum transfer from protons to heavier ions accounts for the observed fact that heavier ions, if accelerated at all, normally reach the same velocity as the protons in the solar wind. Because of the nonlinear relation between dynamical friction and proton–ion velocity difference a minimum proton flux is required to carry a certain ion species in the solar wind. Formulae comparing the minimum fluxes for different ions are given. It is shown that elements up to and beyond iron will be carried along in the solar wind as long as helium is carried along. Substantial isotopic fractionation is possible, in particular in the case of helium. The effects of ion motion and escape on abundances in the corona and in the outer convective zone of the Sun are discussed. (auth)

37102 BEHAVIOR OF THE Fe II 3938-LINE IN PLAGES NEAR THE LIMB. Bergqvist, O. (Swedish Astrophysical Station, Anacapri). Solar Phys.; 12: 416-18(Jun 1970).

A number of spectra secured recently at Anacapri in the region of the K line have made it possible to study the behavior of the Fe II 3938 line in plages situated on the limb or very close to the limb. The effect described by Öhman (1969) is present in these spectra of the disk near the limb in such areas where Ca II plages are present. (W.D.M.)

37103 ATOMIC-BEAM STUDY OF THE SOLAR 7699 Å POTASSIUM LINE AND THE SOLAR GRAVITATIONAL RED-SHIFT. Snider, J. L. (Harvard Univ., Cambridge, Mass.). Solar Phys.; 12: 352-69(Jun 1970).

The shape and redshift of the solar potassium resonance line ($4^2P_{\frac{1}{2}} \rightarrow 4^2S_{\frac{1}{2}}$) at 7699 Å were studied by an atomic-beam resonant scattering technique. Light from the central 10% of the solar image fell on a potassium atomic beam whose scattering wavelength was shifted in a known way by a magnetic field. The line profile was obtained by measuring the scattered light intensity as a function of magnetic field. The time required for a single profile of the line core was 30 to 40 min. Most of the observed profiles were asymmetric and the character of the asymmetry varied in an erratic way from profile to profile. The mean redshift of the 40 profiles which showed small or no asymmetry was: $(\Delta\lambda)_{mean} = 10 \pm 1$ mÅ $= (0.61 \pm 0.06)(\Delta\lambda)_{grav}$, where $(\Delta\lambda)_{grav}$ is the gravitational redshift predicted on the basis of the principle of equivalence. This result, together with those of other recent experiments, is consistent with the previously observed correlation between the redshift of a solar line and its strength. Various checks of the experimental method are discussed, including preliminary measurements on the solar sodium D1 line. (auth)

37104 SOLAR C II RESONANCE LINE PROFILES. Berger, R. A.; Bruner, E. C. Jr.; Stevens, R. J. (Univ. of Colorado, Boulder). Solar Phys.; 12: 370-8(Jun 1970).

The profiles of the solar C II resonance doublet λ1334.6 Å are presented. Possible broadening mechanisms are discussed. (auth)

37105 OBSERVATION OF THE CHROMOSPHERIC FINE STRUCTURE BY THE 53-CM LYOT CORONAGRAPH. Nikolskii, G. M. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow. High Altitude Station of Pulkovo Observatory, Moscow). Solar Phys.; 12: 379-90(Jun 1970).

Methods for the observation of chromospheric spicules with the large coronagraph mounted at the High Altitude Astronomical Station near Kislovodsk are described. The Hα spectrograms and the filtergrams obtained by an Hα–Halle birefringent filter are shown. Some results of the observations and some conclusions on the structure of the chromosphere are reported. (auth)

37106 CHROMOSPHERIC MAGNETOGRAPH. Veeder, Glenn J.; Zirin, Harold (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Solar Phys.; 12: 391-402(Jun 1970).

By comparison of photoelectric magnetograms with high-resolution Hα pictures it is possible to formulate a set of rules by which the magnetic field may be derived directly from the filtergrams. This is possible because of the regularities of magnetic-field configurations on the Sun and because chromospheric morphology is determined by the magnetic field. Off-band pictures (preferably 0.5 Å red) show a well-defined enhanced chromospheric network, the boundaries of which coincide with the 5 G contour of longitudinal field on the Mt. Wilson magnetograms. The actual fields are presumably more concentrated along the dark structure of the network. Higher fields are marked by filled-in cells. Regions of predominantly transverse fields may be inferred from the absence of normal network structure and the presence of chromospheric fibrils. The quiet chromosphere is recognized by the presence of oscillatory motion and the absence of fibrils or strong network structure. Thus, the chromosphere may be divided into three types of regions: enhanced network, horizontal field, and quiet network. The polarity of the magnetic field may be recognized by plage–antiplage asymmetry; that is, the fact that only following magnetic fields show bright plage in the center of Hα. (auth)

37107 FREQUENCY AND STRENGTH OF SHOCK WAVES IN THE SOLAR ATMOSPHERE. Ulmschneider, Peter (Astronomisches Institut, Wuerzburg, Ger.). Solar Phys.; 12: 403-15(Jun 1970).

Comparison of computed radiative energy losses of several new empirical chromospheric models with heating by shock-wave dissipation gives information on the frequency and strength of shock waves in the solar chromosphere. A mechanical flux of around 2.5×10^6 erg/cm² sec is found for the base of the chromosphere. The shocks are weak and the wave period is around 10 sec. (auth)

37108 THERMAL AND DYNAMICAL STABILITY OF PROMINENCES. Nakagawa, Y. (National Center for Atmospheric Research, Boulder, Colo.). Solar Phys.; 12: 419-37(Jun 1970).

A comprehensive examination of the stability of prominences is presented, and the gross behavior of prominences is considered in terms of the stability of an optically thin plasma supported by a magnetic field against gravity, including thermal effects on the energy balance. It is shown that (1) hydromagnetic as well as hydrodynamic waves of short wavelengths could induce instability which leads to the formation of prominences, and (2) in quiescent prominences, the dominant factor which controls the instability is the shear between the permeated and the supporting magnetic fields. The dependence of these instabilities on the radiative loss and other hydromagnetic effects are discussed. (auth)

37109 THE 3.3-mm BRIGHTNESS DISTRIBUTION OF THE QUIET SUN. Shimabukuro, F. I. (Aerospace Corp., El Segundo, Calif.). Solar Phys.; 12: 438-46(Jun 1970).

Center-to-limb brightness distribution measurements of the quiet Sun at a wavelength of 3.3 mm show that there is a slight limb brightening at this wavelength. Within the measurement accuracy of the system used, the limb brightening function is only radially dependent. At 3.3 mm, the measurements are consistent with a solar brightness curve that is flat to about $r = 0.8$ with a rapid increase to a peak value of about 1.3 at the limb. The results show that most of the central disk 3.3-mm emission comes from a thin layer of relatively constant temperature about 1500 to 3500 km above the photosphere. (auth)

37110 HELIUM-LIKE ION FORBIDDEN LINE EMISSION FROM THE SUN. Gabriel, A. H.; Jordan, C. (Culham Lab., Abingdon, Eng.). Phys. Lett., A; 32: 166-7(9 Jun 1970).

A recent theory for interpreting relative line intensities from helium-like ions is re-examined in the light of newer data. New semi-empirical values for the transition probability $1s^2\ ^1S - 1s2s\ ^3S$ are proposed, which lead to higher measured electron densities. (auth)

37111 SOLAR-WIND FLOW PAST OBJECTS IN THE SOLAR SYSTEM. Spreiter, John R.; Alksne, Alberta Y. (Stanford Univ., Calif. Ames Research Center, Moffett Field, Calif.). Annu. Rev. Fluid Mech.; 2: 313-54(1970).

A review is presented of the interaction of the solar wind with objects on which direct measurements have been made: Earth, Moon, Venus, and Mars. The spatial and temporal variations of the solar wind are covered, and the theory based on continuum-fluid concepts of gasdynamics and magnetohydrodynamics is described. The bibliography of 129 references includes much of the review literature of space physics. (D.L.C.)

37112 LOCALISATION OF SOLAR X-RAY EMISSION AT ENERGIES ABOVE 3 keV. Catura, R. C.; Acton, L. W.; Fisher, P. C. (Lockheed Palo Alto Research Lab., Calif.). Nature (London); 227: 55-6(4 Jul 1970).

It is known that solar x-ray emission becomes increasingly localized to active regions as the photon energy increases. Photographs of the Sun at x-ray energies <0.5 keV show emission from the entire corona, whilst those sensitive in the 1- to 3-keV interval show the emission to be concentrated in condensed regions, which are correlated with features at both optical and radio wavelengths. If this trend were to continue x-rays at energies >3 keV would be emitted exclusively from active regions, with little or no contribution from the general corona. The spatial distribution of higher energy x-ray emission from the Sun is, however, largely uninvestigated, principally owing to experimental difficulties associated with the rapidly decreasing intensity of solar x-ray emission with increasing photon energy. The purpose of the experimental work described was to provide a first step in such an investigation and to prove the feasibility of a satellite experiment for this type of measurement. The instrumentation included a highly collimated proportional counter flown on a spin-stabilized rocket launched on Oct. 16, 1968. The counter was sensitive over the range 3 to 30 keV, with a peak efficiency of 70% at 7 keV. The methods of data accumulation are described. A comparison of x-ray and Hα emission from the solar disk is shown graphically. It was determined that at least 92% of the total x-ray emission >3 keV came from plage 9735, and results were consistent with a thermal bremsstrahlung spectrum with a solar temperature of ~10^7K. The data revealed a strong time dependence of solar x-ray pulse. (UK)

37113 THE OSCILLATOR-STRENGTH SCALE FOR Fe I. Bridges, J. M.; Wiese, W. L. (National Bureau of Standards, Washington, D. C.). Astrophys. J.; 161: L71-5(Jul 1970).

Extensive measurements of f-values for about 80 Fe I lines were performed photoelectrically with a wall-stabilized arc at electron densities of about 10^{16} cm^{-3} and temperatures near 10000°K. The measurements include the majority of those lines which have been recently investigated in a number of smaller, as yet unrelated experiments. All these measurements are thus tied together for the first time, and it is found that they generally agree with each other within a factor of 2 or better. On the other hand, the measurements indicate very definitely a strong dependence on upper excitation potential in the widely used data of Corliss and co-workers. While there is good agreement with their data for lines of low excitation potentials, the deviations become as large as factors of 25 for lines starting from higher excitation potentials. (auth)

37114 CLASSIFICATION OF NEW MULTIPLETS IN THE EXTREME-ULTRAVIOLET SPECTRA OF NICKEL, COPPER, AND ZINC. Goldsmith, S.; Fraenkel, B. S. (Hebrew Univ., Jerusalem). Astrophys. J.; 161: 317-20(Jul 1970).

Classification of new $3p^63d-3p^53d^2$, $3p^6-3p^53d$, and $3p^5-3p^43d$ transitions in Ni, Cu, and Zn are given. These transitions are of astrophysical interest. Previous analysis of these transitions, terminating in Ni, have been extended and some published lines of Ni remeasured to a greater accuracy. Some unclassified reference lines of Ti are listed also. (auth)

37115 EXCITATION OF IONIZED BARIUM IN THE CHROMOSPHERE. Tandberg-Hanssen, E.; Smythe, C. (High Altitude Observatory, Boulder, Colo.). Astrophys. J.; 161: 289-302(Jul 1970).

Eclipse observations of Ba(II) emission lines indicate that the ratio of the intensities of the resonance lines, I(K)/I(H), reaches values in excess of 2.5 in the middle chromosphere. To explain this behavior the excitation and ionization equilibrium of barium under chromospheric conditions were computed and the coupling of the 6^2P and the (metastable) 5^2D terms were studied. For sufficiently small values of the interterm collisional strength $\Omega(6^2P_{\frac{3}{2}}-6^2P_{\frac{1}{2}})$ the observed intensity ratios can be reproduced. (auth)

37116 LINE TRANSFER IN TWO DIMENSIONS. Cannon, C. J. (Univ. of Sydney). Astrophys. J.; 161: 255-64(Jul 1970).

A method is presented for solving the equation of radiative transfer for a spectral line formed in a multidimensional atmosphere. The method generalizes the Feautrier solution in one dimension and allows the study of atmospheres which exhibit horizontal fluctuations in all parameters. Model two-dimensional problems are discussed. (auth)

37117 OPACITY OF THE SOLAR CORE. Watson, William D. (Massachusetts Inst. of Tech., Cambridge). Astrophys. J.; 161: 139-44(Jul 1970).

The influence of individual heavy elements on the opacity of the solar core is investigated. Increases and decreases in abundances are considered quantitatively. The recently revised photospheric iron abundance and the possible effects of diffusion are included. Together, these two changes may increase the opacity at the solar center by almost 50% relative to that obtained with a Lambert–Warner photospheric composition. A discussion of the uncertainty in the physical theory is given. Improved opacities are provided in a form that is convenient for solar evolutionary calculations. For opacity considerations, the conditions within main-sequence Population I models having radiative cores are similar to those of the Sun, and the discussion here is relevant for such stars. (auth)

37118 PRELIMINARY COMPARISON OF PREDICTED AND OBSERVED STRUCTURE OF THE SOLAR CORONA AT THE ECLIPSE OF MARCH 7th 1970. Smith, S. M. (Ames Research Center, Moffett Field, Calif.); Schatten, K. H. Nature (London); 226: 1130-1(20 Jun 1970).

Schatten (Nature, 226: 251(1970)) made predictions concerning the structure of the corona at this eclipse, based on a projection on to the celestial plane of the coronal magnetic field resulting from a Green's-function solution for the magnetic potential between the photosphere and a spherical equipotential "source surface" located 2 radii from the solar center. Comparisons are made of photographs of the corona with these predictions; the photographs were taken using a 90-inch focal length Newtonian telescope at the NASA–Langley Research Center, Hampton, Virginia, fitted with a specially designed rapidly rotating sector wedge occulater with radially varying aperture. The chief points of agreement and disagreement are shown in tabular form. It is noted that the helmet at 052°, the largest single structure visible at the eclipse, was correctly forecast and the maximum observed arch height agrees well with prediction. Two cases of clear disagreement are associated with the apparently erroneous location of coronal condensations usually considered to occur above active surface regions, and it is suggested that something associated with the field calculations near active regions was wrong; the source surface used in the calculations may have been located too high above the active regions, and this suggestion is examined. It is concluded that the predominantly open structure of the predicted corona is in agreement on a large-scale basis with the maximum type corona observed. Detailed agreement of intermediate size features is best near older and more stable regions, and worst near coronal condensations. (UK)

37119 PREDICTION AND OBSERVATION OF THE CORONAL STRUCTURE FOR THE SOLAR ECLIPSE OF MARCH 7th 1970. Waldmeier, M. (Swiss Federal Observatory, Zurich). Nature (London); 226: 1131-2(20 Jun 1970).

A comparison is reported between the features of the coronal structure as predicted by Schatten (Nature, 226: 251(1970)) and observations made by the author in Mexico. The most remarkable feature is stated to be a long helmet streamer in the NE quadrant, which is connected with a large filament, and which was correctly predicted. Predictions for an intense long double streamer in the SE quadrant and for a helmet streamer around 300° were also reasonably good. In the innermost corona the brightest regions were over the activity zones at 70°, 105°, 260°, and 295°. The most serious descrepancy between prediction and observation was in the SW quadrant, where the predicted long streamer was completely absent. Coronal arches were predicted in all except the SW quadrant, whereas in fact, arch-like structures were observed in all quadrants and the most pronounced just in the SW quadrant at 250°. An increase in ellipticity compared with the corona of Sept. 22nd 1968 was predicted, but in fact the ellipticity was diminished. (UK)

37120 SOLAR UV FLASH SPECTRUM, 1400 TO 1960 A. Bruechner, G. E.; Bartoe, J. F.; Nicolas, K. R.; Tousey, R. (Naval Research Lab., Washington, D. C.). Nature (London); 226: 1132-5(20 Jun 1970).

Five spectroheliographs were flown on an Aerobee 170 rocket from Wallops Island into the total solar eclipse of March 7th 1970 with a view to photographing and scanning photoelectrically the uv and xuv flash spectrum of the Sun. The instruments are described and the steps in the process by which the rocket altitude was maintained are outlined. The scanning speed of the Moon's limb over the edge of the Sun at second contact was about 0.42 arc s/sec, and the duration of totality was 109 sec. The photographic instruments worked as planned, but the photoelectric instrument did not scan the spectrum owing to motor failure; and because of a failure in the recovery system the payload sank in deep water. It was ultimately recovered, but only the film strips of the middle uv instrument survived. A spectrum representing the combined outer-limb photospheric spectrum, the chromospheric spectrum, and the coronal spectrum is shown. The photospheric continuum above 1800 Å is visible, but fogging makes quantitative measurement impossible. The Si continuum below 1525 Å can also be seen. Some characteristic features of the identified lines are discussed, including lines from neutral elements, from singly ionized elements, from doubly and triply ionized elements, and from highly ionized elements (coronal lines). (UK)

37121 ROCKET OBSERVATIONS OF THE CORONA ON MARCH 7th 1970. Koomen, M. J.; Purcell, J. D.; Tousey, R. (Naval Research Lab., Washington, D. C.). Nature (London); 226: 1135-8(20 Jun 1970).

Observations made from an Aerobee 150 rocket launched on March 7th 1970 from the White Sands Missile Range, New Mexico, ~ 2 hours after the total solar eclipse, are described. The instrument employed consisted of two small Lyot coronagraphs placed side by side. The payload also included an xuv heliograph. It was particularly wished to photograph the white light corona beyond 3 solar radii, where the corona in Earth-based photographs tends to fade into the background when atmospheric conditions are unfavorable. The flight could not be made simulatneous with the eclipse since the full solar disk was required to ensure proper working of the solar pointing rocket control. The coronagraph record from the flight is shown, combined with a ground-based eclipse photograph, and features of the former are discussed. Among conclusions reached are that the range beyond 3 solar radii may not be greatly influenced by the complex magnetic fields nearer the limb, but a dark sector in the SE may indicate some peculiarity of the large scale magnetic field. Streamers were recorded to elongations greater than the 9 $R_\odot$ limit of the coronagraph. The photographs show a prominent equatorial enhancement of the background corona. Preliminary measurements of the equatorial and polar brightness are also shown, and the data include the local effects of the streamers. The curves show the equatorial enhancement, as well as the enhancement between 3 and 6 $R_\odot$ in the polar regions produced by streamers. Successively longer exposures of

the solar disk image, obtained with the heliograph, are depicted; the most striking features are the corona-like emission above the limb and a narrow limb-brightened ring around the entire disk. Emission mechanisms are discussed. The low xuv corona observed on March 7th 1970 showed considerable resemblance to the low white light corona photographed on the same date, except that the former has depressions not seen in the latter. It has been noted that limb brightening may be suppressed in the neighborhood of Hα limb prominences. (UK)

37122 LOCKHEED–AEROSPACE ECLIPSE EXPEDITION. Martin, D. C.; Smith, S. F.; Chapman, G. A. Nature (London); 226: 1138–9(20 Jun 1970).

The program of work of this expedition in connection with the solar eclipse of March 7th 1970 is described. Four coronal photographic experiments were carried out. The first of these experiments used an f/12 plane polarising telescope of 24-inch focal length to observe the coronal green line at 5303 Å; the chief value of the green-line photographs is in the study of coronal rays, arches, and other structural details. A close correspondence was found in the general appearance of the green line corona with the white light corona. The green line structure was sparse at the poles and pronounced in active regions. A system of cloud coronal arches was visible in the NW quadrant. The largest of the prominences visible during the eclipse was an extension of the large filament on the NE quadrant of the solar disk seen in Hα light. Above a small prominence on the NW limb concentric arches within a helmet could be seen in the green line photographs. Another camera used aero infrared Ektachrome to obtain pictures of the corona; streamers could be seen out to nearly five solar radii. A third instrument used a 680-mm focal length solid catadioptic objective and was employed for white light color photography of the entire eclipse. These photographs showed the diamond ring effect, Baily's beads, prominences, and the inner corona and outer corona to a distance of 2.3 $R_\odot$. Broad-band Hα pictures of high contrast were taken for details of the coronal ray structure using a 4-inch Questar telescope with a 250-Å passband filter centered at 6563 Å. (UK)

37123 SWISS SOLAR ECLIPSE EXPEDITION TO MEXICO. Waldmeier, M. (Observatoire Astronomique Federal, Zurich). Nature (London); 226: 1139–40(20 Jun 1970).

This expedition carried out a program of photometric, polarimetric, and spectroscopic observations of the solar corona at the eclipse of March 7th 1970. Motion pictures were also obtained of the eclipse and color photographs of the corona. In order to observe the green line at 5303 Å a low-dispersion spectrograph of high luminosity was used, which could be rotated about its collimator axis so that the radial distribution of the intensity of the green line could be measured at 16 different position angles and out to about 1 $R_\odot$ from the limb. A thorough knowledge of the electron density is needed for interpretation of the line intensities and their variations; this was achieved by observing the distribution of the white light of the corona, using cameras of focal length 120 and 150 cm. The white light is photospheric light scattered by free electrons and the photometric measurements could easily be transformed into electron densities. A camera of 8-m focal length was used to photograph the inner parts of the corona, where it shows the most interesting structures especially over centres of activity; these structures are formed by magnetic fields emanating from deeper layers, and their examination provides the only way to obtain an insight into the shape of the magnetic fields in the immediate surroundings of the Sun. An extensive program of polarimetric measurements was carried out, using a camera of 120-cm focal length, to determine the inclination of streamers to the line of sight. (UK)

37124 LOS ALAMOS AIRBORNE OBSERVATIONS. Cox, A. N. (Los Alamos Scientific Lab., N. Mex.). Nature (London); 226: 1140–1(20 Jun 1970).

The eclipse of March 7th 1970 was observed off the east coast of Mexico from an Air Force NC-135 A instrumented for chromospheric, coronal, and geophysical observations. The aircraft altitude was 36,830 ft, and the duration of observation was 5½ min. The chromospheric and coronal observations were made by instruments with combinations of gyro and photoelectric tracking. The unusually spiky appearance of the active corona was recorded out to 13 radii from the solar center, using a camera with an f/6 lens of 610-mm focal length. Lower-resolution photographs were taken with an emission-line camera. Forbidden emission lines observed were 5303 Å (Fe XIV), 6374 Å (Fe X), 5694 Å (Ca XV), 7892 Å (Fe XIII), and 5890 Å (Na I). A Fourier transform infrared spectrometer was used to measure the chromospheric and coronal spectra in a circular spot of 10 min arc at both the second and third contact points. The spectrum was recorded with a resolution of 2 cm^{-1}, including the emission lines of Si X, He I, and H I, using an InSb detector at wavelengths between one and three μ. An f/8 telescope of 80-in. focal length was used to record the line shape of the green and red Fe lines in the corona. The behavior of the 5577 Å and 6300 Å forbidden neutral 0 emission lines and the 3914 Å N_2^+ emission line from the Earth's upper atmosphere was also recorded along paths through and in the lunar umbral shadow. Scans between the lunar direction and 30° from the horizon in the direction perpendicular to the umbral path were made in order to study excitation mechanisms for the airglow when the solar light was rapidly cut off. (UK)

37125 CHANGES IN THE LOWER IONOSPHERE DURING THE ECLIPSE OF MARCH 7th 1970: A PRELIMINARY REPORT OF THE CANADIAN PROGRAM. Nature (London); 226: 1100–7(20 Jun 1970).

Ground-based radio investigations and four rocket launches were carried out in Canada with a view to investigating the effect of the eclipse on the solar radiation and electron densities in the lower ionosphere (below about 150 km). The experimental work is described in the following four papers:- (1) Introduction, J. S. Belrose (Department of Communications, Ottawa), A. G. McNamara, and J. E. Hall; (2) Radio propagation experiments, J. S. Belrose, L. R. Bode, R. Bunker, and M. D. Ross (Department of Communications, Ottawa); (3) Probe experiments, A. G. McNamara (NRC, Canada); and (4) Observations of solar ionising radiations during the eclipse, J. E. Hall, P. H. G. Dickinson, and A. J. Hall (Radio and Space Research Station, Slough, Eng.). (UK)

37126 CORONA DURING THE MARCH 7th 1970 ECLIPSE. Newkirk, G.; Lacey, L. (High Altitude Observatory, Boulder, Colo.). Nature (London); 226: 1098(20 Jun 1970).

A brief description is given of the structure of the corona, together with a photograph as observed from the "High Point" camp (16°20'N, 8800 ft) about 30 miles SW of San Carlos, Mexico, by the eclipse expedition of the High Altitude Observatory of the National Center for Atmospheric Research. (UK)

37127 PHOTOMETRIC STUDY OF THE SOLAR CORONA. Koutchmy, S.; Laffineur, M. (Institut d'Astrophysique, Paris). Nature (London); 226: 1141–2(20 Jun 1970).

Some photographs are reproduced of the K and F solar corona taken from Mexico during the eclipse of March 7th 1970, using the technique described in Nature, 222: 461(1969), improved by employing a graded filter. The method allowed the polarization of the fine structure in the electronic corona to be evaluated, thus providing precise photometry of structures in the K electronic corona, as well as the F corona. The filament structure was evident and the dispersion of the intensities of the various streamers, as well as their superposition, indicated that a large range of streamers was registered, situated in quite distinct planes. The "dark filaments" (Astrophys. Lett., 3: 215(1969)) were again observed; it seems impossible to interpret these structures as "holes" in the corona. It was shown that the polarization rate increased rapidly from the limb to a maximum value at $\rho \sim 1.4$ and then decreased because of the growing importance of the nonpolarized F corona. (UK)

37128 DOPPLER TEMPERATURE OF THE SOLAR CORONA. Hirschberg, J. G.; Wouters, A.; Fried, W. L.; Cooke, F. N.; Duke, D.; Read, M. (Univ. of Miami, Coral Gables, Fla.). Nature (London); 226: 1142–3(20 Jun 1970).

Information on the Doppler temperature and motion of the corona, as far out as 1.85 solar radii, was obtained from observation of Fe XIV in the solar corona, Fe XIV $3p^2P_{\frac{1}{2}} - {}^2P_{\frac{3}{2}}$, at λ = 5302.86 Å made with Fabry–Perot interferometers both photographically and using a photomultiplier. In contrast to previous observations, the data indicated that the corona is in violent motion, as shown by definite spectral shifts and differences in Doppler temperature. The exposures used (5, 15, and 60 sec) were long enough to provide fringes extending to large distances from the Sun. Details are given of the interferometer setup and method of operation. The corrected Fabry–Perot pattern obtained gave line shapes and wavelength shifts without complications arising from the very steep intensity gradient of the corona. Preliminary results indicate that the half intensity width of the green coronal line during the eclipse of March 7th 1970 varied between 0.8 and 1.1 Å and that the intensity distribution was unequal, with large intensities in the southern hemisphere and in an active area extending up to 1.8 solar radii towards the NE. The latter active area corresponds to the prominence and the strong arches and fan rays observed in this region, and appears of particular interest because of the associated large variations of width and wavelength shifts. The results would appear to reinforce the belief that the connection between the prominences, the coronal streamers and the emission corona deter-

mines the structure of the corona, since they indicate a cooler fan system slowly rotating around a hotter and less dense plasma. The possibility of relating the wavelength shifts to broadening of the line is being considered; such a relationship could show a correlation between motion in the corona and the temperature, and perhaps give a clue to the heating mechanism. (UK)

37129 OUTER CORONA AT THE ECLIPSE OF MARCH 7th 1970. Menzel, D. H.; Pasachoff, J. M. (Harvard Coll. Observatory, Cambridge, Mass.). Nature (London); 226: 1143-4 (20 Jun 1970).

It is stated that preliminary results from an expedition to Mexico indicate that the K corona may be dominant at much greater distances from the Sun than had previously been thought. In order to separate the F and K coronas four kinds of experiments were carried out. In the first a new spectrograph registered the coronal spectrum from 3500 to 6000 Å. Secondly, four television cameras recording on videotape scanned the corona over a field of 5×7 solar diameters, with rotating polaroids and different neutal and colored filters. Thirdly, the coronal polarization was photographed, and fourthly the corona was photographed with a variety of different lenses. The corona appeared stellated, with long streamers visible to at least four or five solar diameters, both to the naked eye and on long-exposure-calibrated photographs. The streamers were straight and apparently unaffected by the curvature that solar rotation might induce; they also showed strong polarization. Since the F corona should be symmetric around the limb, and structureless and unpolarized, the character of these streamers and many other shorter rays indicated that they comprised the K corona. There were indications that the streamers decreased in intensity away from the Sun at approximately the same rate as the overall coronal radiation. (UK)

37130 VARIATIONS IN LINE PROFILES FROM PHOTOSPHERE TO CHROMOSPHERE. Houtgast, J.; Namba, D.; Rutten, R. J.; de Graauw, T. (Observatory Sonnenborgh, Utrecht). Nature (London); 226: 1144-5(20 Jun 1970).

Observations of the March 7th 1970 eclipse were made from Mexico, near the center line of totality, employing a high resolution Lithrow-type grating spectrograph fed by a coelostat. The region from 4545 to 4579 Å was photographed simultaneously on two 70-mm films with respective intensities of 8 and 90%, using a beam splitter, at a dispersion of 1.7 mm $Å^{-1}$. Calibration spectra of the central part of the solar disk were also taken before and after the eclipse. In addition, in the same spectrograph, the region of the Mg b lines near 5200 Å was focused on a multiplex chopper and the coded spectrum was recorded on magnetic tape. Provisional microphotometric records in transmission of the photographic spectra at second contact were made, but because of differences in photographic densities and the adjustment of the photometer the records show only qualitative differences in the appearance of spectral lines of different atomic and ionic origin in the transition from photosphere to chromosphere. Full reduction of the spectra will take some considerable time, but eventually it is hoped to obtain true line profiles of the outer limb and the transition region to the chromosphere. (UK)

37131 ASSOCIATION OF CORONAL STRUCTURES WITH CHROMOSPHERIC STRUCTURE. Teske, R. G.; Hutchinson, A. K.; Iwanski, J. R.; Soyumer, T. (Univ. of Michigan, Ann Arbor). Nature (London); 226: 1145-6(20 Jun 1970).

A description is given of the coronal structures and their apparent relationship to chromospheric features observed in Hα and Ca II K at the McMath–Hulbert Observatory, Michigan, during the eclipse of March 7th 1970. Photographs are reproduced, together with a schematic sketch showing the more significant features. The coronal features most prominent on the photographs and their probable association with activity in the chromosphere are indicated in tabular form. Especially noteworthy is the position angle of the cleft directly in the south and the decided difference in the appearance of the coronal structure within about 30° of each pole. Maximum dimensions and positions of the arches, as estimated from the photographs, are given. Also shown is an Hα filtroheliogram to aid in the identification of structures on the visible disk. An extensive well-developed filament was also observed, with an associated major helmet streamer and arches. The effect of flaring activity is also discussed, together with other observed features. There were also indications that on the day before the eclipse a proton flare may have occurred behind the west limb, giving rise to a bright surge. The two most prominent features on the photographs are the major helmet streamer, already mentioned, and a bright structure just north of the light surge of the previous day. This bright structure was apparently part of the southern edge of a streamer seen superposed with other structures. There are three possible plage candidates for the chromospheric origin of this strongly tilted streamer. (UK)

37132 PHOTOSPHERIC MAGNETIC FIELDS ON MARCH 7th 1970. Livingston, W.; Harvey, J.; Slaughter, C. (Kitt Peak National Observatory, Tucson, Ariz.). Nature (London); 226: 1146-8(20 Jun 1970).

A magnetogram is shown for the March 7th 1970 eclipse day, together with magnetograms taken one week before and after the eclipse day. The latter may be of some value for the interpretation of limb observations, although the evolutionary change with time makes any comparison inexact. A 40-channel magnetometer was employed for the observations, the mode of operation of which is described. Suitable amplifiers and phase-locked detectors were used, and magnetic and brightness signals were recorded on magnetic tape. The magnetic data are shown as computer-drawn intensity maps; weak fields were emphasized and a peak field limit was set arbitrarily at 2,000 G. Maximum field strength for sunspot umbrae are also shown. (UK)

37133 Hα FILTERGRAMS OF THE SUN ON MARCH 7th 1970. Caulk, H.; Hobbs, R. W. (Goddard Space Flight Center, Greenbelt, Md.). Nature (London); 226: 1148-9(20 Jun 1970).

Some Hα filtergrams of the Sun obtained during and subsequent to the eclipse of March 7th 1970 are reproduced. The filtergrams were taken with a Zeiss 96-inch-focal-length telescope, using a 0.5-Å Halle interference filter. Prominences are shown and a bright plage area near the SW limb is regarded as particularly interesting; this region was the site of a 1 N flare, and also several subflares and considerable surge activity before, during, and after the eclipse. A prominence is seen that was possibly associated with this bright plage. Other flares are also indicated, and a striking filament of length apparently greater than 500,000 km is seen. (UK)

37134 OBSERVATIONS AT THE SAGAMORE HILL SOLAR RADIO OBSERVATORY. Straka, R. M.; Castelli, J. P. (Air Force Cambridge Research Labs., Bedford, Mass.). Nature (London); 226: 1149-52(20 Jun 1970).

The Sun was monitored during the eclipse of March 7th 1970 with radiometric receiving equipment at 114, 245, 606, 1415, 2695, 4995, 8800, 15,400, and 35,000 MHz; the eclipse at the site was 96.2% of total. The radio spectrum and history of the active-region McMath 607 are discussed, and consideration is also given to the residual emission at eclipse maximum, together with spectral data in terms of changes in the solar spectrum during the sunspot cycle. The percentage changes in flux per minute caused by occultation of the radio source overlying plage 607 are shown for sources of wavelength 21.2, 11.1, 5.0, 4.29, and 3.4 cm for both the covering and uncovering phases of the eclipse, and it was found that the changes were more sharply defined during the uncovering of the source. An unexpected effect was that the shorter-wavelength sources were occulted first. Source dimensions were small, probably because of association of the source with the isolated alpha spot group. Flux densities for the region at the various wavelengths were obtained by integrating the area under the flux curves, and the data are shown tabulated. The spectrum and low intensity of the source precluded resolution at all the frequencies monitored, but the spectral curve resembles those of strong sources where the magnetic field introduces resonance absorption at harmonics of the gyromagnetic frequency. Brightness temperatures for the region were determined from the measured flux values and the source sizes. A circular distribution of sources was assumed for simplicity of computation. Since the eclipse was almost total it was possible to consider the residual flux at maximum phase as coming from beyond the solar disk, and a plot of relative brightness temperature against frequency for the residual was obtained. The spectral index of the Sun at centimetre wavelengths was also approximated for different periods of the sunspot cycle. Some comparisons are made with data from the November 12th 1966 eclipse. The apparent nonradial distribution of the source seemed real and confirms earlier findings. (UK)

37135 16-GHz OBSERVATIONS OF THE ECLIPSE OF MARCH 7th 1970. O'Brien, K. C.; Graedel, T. E.; Owens, G. J.; Ierley, W. H.; Doles, J. H.; Nagelberg, E. R. (Bell Telephone Labs., Murray Hill, N. J.). Nature (London); 226: 1152-3(20 Jun 1970).

Preliminary results are reported using a transportable radiotelescope located at Virgina Beach working on a two-beam technique allowing subtraction of the atmospheric emission background and leaving only the signal due to the Sun. One beam was directed at the Sun and the other was −3.5° from the Sun in right ascension. A superheterodyne receiver having a mixer with a balanced Schottky barrier diode was employed. The signal was synchronously detected during the eclipse using a 12-sec time constant and recorded on strip chart recorders, and the signal resolution was about 1 part in 10^4. The basic eclipse data at 16 GHz are shown graphically and the points of first and fourth contact for the radio data are indicated. The data indicated an average 16-GHz

radio diameter for the Sun of 1.038 ± 0.002 times the optical diameter. The maximum of the radio eclipse occurred 18 ± 4 sec after the optical maximum, implying an asymmetry of the radio Sun as a result of extended emission from regions on the NE limb. The data also indicated that the McMath plage region on the SW limb was a small but bright source at 16 GHz. The residual signal at maximum eclipse was 2.6 ± 0.2% of the uneclipsed solar value, implying a solar radio diameter 1.039 times the optical diameter. The presence of a cool region on the disk was also indicated, and effects of sunspots and other nonuniformities were also seen in the data. (UK)

37136 OBSERVATIONS WITH A 7-GHz POLARIMETER. Matsuura, O. T.; Sealise, E.; Marques dos Santos, P.; Kaufmann, P. (Mackenzie Univ., Sao Paulo, Brazil). Nature (London); 226: 1153-4(20 Jun 1970).

Observations of the eclipse of March 7th 1970 with a polarization solar radio telescope at AFCRL, Hamilton, Mass., where the magnitude of the eclipse was 0.96, are reported. Two outputs from the equipment were available, one proportional to the total solar flux and the other to the difference in flux between the RH and LH components of circular polarization, the degree of polarization being the ratio of the outputs. Solar activity was also monitored before and after the eclipse date. Shortly before the eclipse maximum only the northern hemisphere of the Sun was visible, and the polarization was left-handed; this supports the possible emission of polarized radio waves from the northern solar hemisphere, but is not certain since important coronal condensations that could influence the polarization effect were reported by optical observers. At least two extended strongly active regions were identifiable, one with intensity >10 flux units and the other >40. With one exception the active regions were not strongly polarized; this exception contributed 48 flux units and, during its eclipse, a smaller region with strong RH polarization was covered; its degree of polarization was about 10%, and it could have been the preceding part of a relatively complex sunspot group. Burst activity at metric wavelengths was also reported, at time close to the eclipse maximum. The residual flux at eclipse maximum was nearly 8% of the total solar flux and nearly 13% of the quiet solar flux. The existence of detectable coronal radio emission at 7 GHz was expected for heights <1.2 solar radii. (UK)

37137 RADIO OBSERVATIONS OF DISTRIBUTION OF CHROMOSPHERIC BRIGHTNESS TEMPERATURE. Simon, M. (State Univ. of New York, Stony Brook); Buhl, D.; Cogdell, J. R.; Shimabukuro, F. I.; Zapata, C. Nature (London); 226: 1154-5(20 Jun 1970).

It is stated that models of the temperature and density distributions in the solar chromosphere may be tested by radio observations of the dependence of the brightness temperature on wavelength and position across the solar disk. The high resolutions necessary to resolve structure near the limb can be attained during an eclipse, and appropriate studies were organized among those observatories near the eclipse path of March 7th 1970 that could observe at cm and mm wavelengths. Discussion is restricted to data obtained at 3.4 mm and 1.35 cm. The general technique was to position the axis of the main beam of the antenna on the first and last contact positions on the lunar limb and to track those positions as they crossed the limb of the Sun. In between the times of first and last contact high resolution observations of other regions on the Sun were also possible by tracking the appropriate position on the lunar limb. The 3.4 mm data obtained at first contact are shown, the data points being taken every 6 sec with a time constant of 1 sec. Correction was made for atmospheric extinction. Data are also shown for 1.35 cm, taken every second with a 2-sec time constant. Both records yield information on regions much nearer to the solar limb than hitherto available. A general roughness of brightness temperature is evident in both records, and the amplitude is much greater at 1.35 cm than at 3.4 mm. It was interesting to note that the size scale of the resolved fluctuations is comparable to the typical size of the chromospheric network, and it may be speculated that the fluctuations are in fact determined by that network. Allowing for the generally undulating nature of the 3.4-mm distribution there is little, if any, direct observational evidence of limb brightening. There was, however, clear evidence of limb brightening in the 1.35-cm observations from the generally enhanced brightness temperature at the time of last contact. (UK)

37138 FRAUNHOFER LINE STATISTICS. Allen, C. W. (London Univ.). Mon. Notic. Roy. Astron. Soc.; 148: 435-53 (1970).

Counts were made of the numbers of Fraunhofer lines per frequency and per equivalent width ranges. The counts were corrected for solar line obscuration in the violet and for atmospheric line obscuration in the infrared. In order to make comparable statistical calculations, equivalent widths were related by curve-of-growth methods to the statistical intensity factor J. The earlier tabulations were then used to derive statistical line number densities. The general distributive agreement between statistics and counts is good but the mean ratio (statistic/count) has a discrepancy of about +0.5 dex. A similar comparison was made separately for the statistics and counts of 20 neutral atoms and 11 first ions. It was found that the (statistic/count) discrepancy applied only to the neutral atoms and was greater for the rich spectra such as Fe. The main cause of the discrepancy was found to be in the selection of the effective ionization potential i_e used for the earlier statistical analysis. It is concluded that the earlier policy, of extrapolating level densities of some atoms to the ionization limit and beyond, introduces many levels and lines that do not exist. Correction factors for use with earlier tables are proposed. (auth) (UK)

37139 VARIATION OF SOLAR RADIATION AT MODENA DURING PARTIAL ECLIPSE OF MAY 20, 1966. Saltini, Gianfranco (Univ., Modena, Italy). Ass. Geofis. Ital., Atti Conv. Annu.; 16: 101-10(May 1967). (In Italian).

From 16th Annual Conference of Italian Geophysical Society, Naples, Italy. See CONF-670532.

During phases of the solar eclipse, global, direct sun radiation measurements were made in different ranges of the spectrum. The graphs so obtained were compared with the curve of light that the optical state of the phenomenon presents. Then the variation of the spectral composition is noted after comparison with the spectrum in the absence of eclipse. (auth)

Galaxies

Refer also to abstract 37074.

37140 EXCHANGE OF GRAVITATIONAL ENERGY DURING A COLLISION OF GALAXIES. Sastry, K. Shankara; Alladin, Saleh Mohamed (Osmania Univ., Hyderabad, India). Astrophys. Space Sci.; 7: 261-71(May 1970).

The problem of the change in internal energy of a colliding galaxy due to tidal effects is considered, assuming that the galaxies may be regarded as spherical stellar systems whose overall structure remains unchanged during the collision and that the stars move in circular orbits. The numerical estimates thus made for the energy gained by the stars during the collision are compared with those derived on the basis of the assumption that the motions of the stars may be neglected during the encounter (the "impulsive approximation") to test the adequacy of the latter approximation. If the two galaxies are of 10^{11} $M_\odot$, of radii 10 kpc and of mass distribution that of a polytrope of index n = 4; and if the relative distance and velocity at their closest approach are taken as 2 kpc and 1000 km/sec respectively, the mass of escaping stars from a galaxy is estimated to be roughly 4% of the total mass of the galaxy and the total increase in the internal energy of a galaxy during the collision due to the tidal acceleration of all its stars is equal in magnitude to approximately 25% of its initial internal energy, about one-fifth of which is associated with the escaping stars. (auth)

37141 MEASUREMENTS OF NEUTRAL ATOMIC HYDROGEN IN RELATIVELY EARLY TYPE GALAXIES. Bottinelli, L.; Chamaraux, P.; Gouguenheim, L.; Lauque, R. (Observatoire, Meudon, France). Astron. Astrophys.; 6: 453-9(Jul 1970).

The neutral atomic hydrogen content of 34 galaxies and systemic radial velocities of 44 galaxies with relatively small angular diameter were measured with the Nançay radio telescope. Special attention was given to early-type galaxies: 4 lenticular galaxies and 6 spiral galaxies of type Sa were measured. Determinations of systemic radial velocities were made for 5 galaxies with previously unknown velocities; their group membership was confirmed except for one of them. Correlations previously found were confirmed and extended to earlier morphological types. (auth)

37142 LOW-FREQUENCY COSMIC NOISE OBSERVATIONS OF THE CONSTITUTION OF THE LOCAL SYSTEM. Alexander, J. K.; Brown, L. W.; Clark, T. A.; Stone, R. G. (Goddard Space Flight Center, Greenbelt, Md.). Astron. Astrophys.; 6: 476-80(Jul 1970).

Based on measurements of the low-frequency continuum radiation of the galaxy, estimates are obtained for the gross distribution of thermal electrons, the synchrotron radiation emissivity, and the flux and spectrum of low-energy cosmic-ray electrons for the interstellar medium in the Local System. The volume emissivity of the synchrotron radiation at 1 MHz is 10^{-39} W/(m^3 Hz sterad). This value exceeds the emissivity deduced from measurements at higher frequencies over longer path lengths and in

turn implies a low magnetic field between spiral arms (≤1 μG). For a mean interstellar magnetic field of 3 μG near the Sun, the radio data indicate a cosmic-ray electron intensity at 0.3 GeV of 10^4 el/(m^2 s sterad GeV). That this intensity exceeds the value obtained from direct measurements by a factor of ~ 100 suggests either a large residual solar modulation or gradients in the interstellar distribution of cosmic rays. (auth)

37143 POSSIBLE METHODS OF THE DEFINITION OF REAL ECCENTRICITY OF ELLIPTICAL GALAXIES. Denisyuk, E. K.; Tumakova, O. A. Tr. Astrofiz. Inst. Akad. Nauk Kaz. SSR; 12: 125-49(1969). (In Russian).

Orientation and real eccentricity of elliptical galaxies is considered. The functions of changing of the eccentricity of isophotes in dependence on the distance from the center are discussed in detail. These functions were found for 68 elliptical galaxies from the Palomar Atlas with the help of the mounting, which is described. The curves for these functions are given. Galaxies with real considerable eccentricity were distinguished. The statistical confirmation was conducted and it is shown that sometimes one can divide giant and dwarf elliptical galaxies with the help of the function of eccentricity of isophotes. (auth)

37144 KINEMATICS OF THE COMA CLUSTER OF GALAXIES. Gainullina, R. Kh. Tr. Astrofiz. Inst., Akad. Nauk Kaz. SSR; 12: 113-24(1969). (In Russian).

It is shown that the redshifts of 26 galaxies that are probably Coma cluster members, when combined with the results of statistical investigation of this cluster, are compatible with the hypothesis that the cluster members within 100′ of the cluster center rotate around the latter along their flat orbits while slowly moving away. It is estimated that the mean mass of a cluster member is about $3 \times 10^{11}\ M_\odot$, the period of rotation at a distance of 72′ from the cluster center is about 5×10^{12} years, and the lower limit of the age of the Coma Cluster is about 5×10^9 years. (auth)

37145 LUMINOSITY AND MASS FUNCTIONS FOR THE FIELD GALAXIES OF VARIOUS TYPES. Genkina, L. M. Tr. Astrofiz. Inst., Akad. Nauk Kaz. SSR; 12: 106-12(1969). (In Russian).

Using the catalogue of radial velocities of galaxies by Humason, Mayall, and Sandage (1956), the luminosity functions of field galaxies for different morphological types were constructed. With these luminosity functions and mass–luminosity relations, mass functions for galaxies of different types were calculated. Average masses for galaxies of each type were determined. (auth)

37146 POWER CHARACTERISTICS OF GALAXIES OF HUBBLE'S SEQUENCE. Genkina, L. M. Tr. Astrofiz. Inst., Akad. Nauk Kaz. SSR; 12: 97-105(1969). (In Russian).

Potential energy, kinetic energy of rotation, thermal kinetic energy, and complete and specific moments of impulse are given for middle galaxies of Hubble's sequence. (auth)

37147 STATISTICAL STUDIES OF THE MASS AND DENSITY OF GALAXIES. Genkin, I. L.; Genkina, L. M. Tr. Astrofiz. Inst., Akad. Nauk Kaz. SSR; 12: 90-6(1969). (In Russian).

A statistical study of masses of galaxies was made. The fundamental mean characteristics (masses, dimensions, angular momentum, etc.) of various types of galaxies are given. (auth)

37148 STRUCTURE AND DYNAMICS OF TYPICAL STELLAR SYSTEMS. Idlis, G. M. Tr. Astrofiz. Inst., Akad. Nauk Kaz. SSR; 12: 17-33(1969). (In Russian).

A critical survey is given of investigations covering the past ten years of general, theoretically possible properties of typical selfgravitating stellar systems (so called, regular galaxies): rotation as a characteristic property of real stellar systems; normality of the fact that real rotating stellar systems have an equatorial plane of symmetry; triaxial ellipsoid of dispersion of star peculiar velocities as the general case for real rotating stellar systems; the universal law of circular velocity in the equatorial plane of symmetry of real rotating stellar systems and the natural models of galaxies; rotation and structural peculiarities of real galaxies, gravitationally interacting or one mutual collision models. (W.D.M.)

37149 STUDIES OF STELLAR DYNAMICS. Genkin, I. L. Tr. Astrofiz. Inst., Akad. Nauk Kaz. SSR; 12: 34-74(1969). (In Russian).

Topics covered in this review include: density waves in homogeneous gravitating media; relaxation and viscosity in stellar systems; approximation of stellar systems to equilibrium states; principles of constructing galactic models; and evolution of forms of dissipating stellar systems. (W.D.M.)

37150 MASS AND DENSITY OF EXTRAGALACTIC NEBULAE. Genkin, I. L.; Genkina, L. M. Tr. Astrofiz. Inst., Akad. Nauk Kaz. SSR; 12: 82-9(1969). (In Russian).

A new catalogue of galactic masses determined by direct methods is given. The mass–luminosity relations are determined. Holmberg's color–density dependence for galaxies is criticized. (auth)

37151 FILAMENTARY NEBULOSITY IN THE VICINITY OF LOOP III. Elliott, H. K. (Univ. of Manchester, Eng.). Nature (London); 226: 1236(27 Jun 1970).

Projecting from the plane of the Galaxy are three loops of nonthermal radio emission. Loop III is 71° in diameter and is centered near the north celestial pole, and it has been suggested that these radio loops are supernova remnants, in which case filamentary nebulosity surrounding their radio ridges should be observable, as in the case of well-known supernova remnants such as the Cygnus Loop. In early attempts to detect optical emission from these high-latitude radio loops no nebulosity was observed, but a more recent investigation showed very faint diffuse nebulosity associated with Loops I and II, in the latter case the nebulosity was similar in structure to the NGC 6960 feature of the supernova remnant in Cygnus. A more extensive photographic survey of the radio loops was made at the high-altitude observatory at Pic-du-Midi, using a widened-field filter camera, with a total exposure of 60 hr on Loops I and III. Two arcs of filamentary nebulosity in the vicinity of Loop III were discovered; microdensitometry measurements showed the filaments to have a maximum brightness of $\sim 5 \times 10^{-3}$ erg/cm²/s/sr in Hα + [N II], corresponding to one-tenth of the brightness of NGC 7000. A remarkable feature of this nebulosity is that it lies at such a high galactic latitude. It seems possible that these filaments are associated with Loop III, just as the arc of nebulosity in Cetus seems to be associated with Loop II. The discovery of these filaments on the outer edge of the radio loop strengthens the theory that the radio loops are supernova remnants. (UK)

37152 ORIGIN OF GALACTIC GAMMA RAYS. Stecher, T. P.; Stecker, F. W. (Goddard Space Flight Center, Greenbelt, Md.). Nature (London); 226: 1234-5(27 Jun 1970).

The authors had previously suggested that the gamma radiation from the galactic disk observed by Clark et al. (Astrophys. J. Lett. 153: L.203 (1968)) from OSO-3 arises from the decay of neutral pions produced by cosmic rays interacting with the nucleons of interstellar gas, much of which was suggested to be molecular hydrogen. The present communication discusses some tentative support for this hypothesis by Kraushaar, who showed that the spectrum of the OSO-3 gamma rays closely matches the gamma-ray spectrum of the horizon albedo from the Earth which arises mainly from the decay of neutral pions produced by the interaction of cosmic rays with the Earth's atmosphere. It is concluded that the pion decay hypothesis, with a total mean nucleon density of ~2 cm^{-3}, provides a natural and adequate explanation for both the intensity and spectral characteristics of the radiation observed by Clark et al. Gamma rays originating in the galactic disk most likely result from the decay of neutral pions produced in interstellar cosmic-ray interactions, and the excess originating in the region of the galactic center could be produced by a combination of the pion decay process and Compton interactions between cosmic-ray electrons and infrared radiation. These explanations obviate the need to invoke strong gamma-ray point sources, large gradients in the galactic cosmic-ray flux, or 8°K greybody radiation fields of galactic extent. (UK)

37153 INTERSTELLAR EXTINCTION BY GRAPHITE, IRON, AND SILICATE GRAINS. Wickramasinghe, N. C. (Cambridge Univ., Eng.); Nandy, K. Nature (London); 227: 51-3(4 Jul 1970).

Earlier work on this topic is briefly reviewed. The data appear to confirm the presence of a graphite component in the grains, but the continued rise in the extinction curve for $\lambda < 2000$ Å presents difficulty for pure graphite models. The possibility that interstellar extinction is caused by a mixture of graphite, iron, and silicate grains is discussed, with the iron grains playing a dominant part in the far uv. The occurrence of these materials is likely through processes involving mass ejection from cool stars, explosions of "massive objects," and supernovae. In order to determine the relative proportions that may be involved, reference is made to the available data on interstellar extinction and on the diffuse galactic light. Theoretical extinction curves were computed for a wide range of combinations of graphite, iron, and silicate grains. The presence of all three constituents seems necessary to account for the data. Detailed calculations are given for one particular distribution of particle sizes, but the conclusions are not strongly dependent on any particular distribution. The findings support the view that interstellar extinction is caused by a mixture of the three highly refractory components, graphite, iron, and silicate grains. Calculated fractions of extinction arising from these three components are tabulated. (UK)

37154 BRIGHTEST MEMBERS OF CLUSTERS OF GALAXIES. Peterson, B. A. (Australian National Univ., Canberra). Nature (London); 227: 54-5(4 Jul 1970).

It has been stated by other workers that the dispersion in the absolute magnitude of the brightest galaxies in rich clusters is only of 0.3 magnitude. It has also been suggested that this small dispersion is simply a consequence of the cluster luminosity function. The present author shows that the distributions predicted by statistical theory vary with the richness of the cluster. Peach, however, considered that the statistical theory is inadequate (Nature 223: 1140 (1969)). The present communication discusses Peach's criticisms, and it is concluded that the magnitude dispersions and the mean magnitude of the various richness classes, predicted by the statistical theory, adequately represent the observations. In addition to its consequences for theories of galaxy formation and the formation of clusters the apparent success of the statistical theory in interpreting the magnitude distributions of the brightest galaxies in clusters has important consequences in the interpretation of the redshift–magnitude relationship used to evaluate cosmological parameters. (UK)

37155 NONTHERMAL RADIO EMISSION FROM AN INFRARED OBJECT IN THE REGION OF IC 1805. Bell, M. B. (National Research Council of Canada, Ottawa); Seaquist, E. R.; Braun, L. D. Astrophys. J.; 161: L13-15(Jul 1970).

The results of a search for radio emission at 9.26, 4.5, and 2.8 cm from two infrared objects discovered by Maffei are reported. Maffei's object 2 is found to possess detectable radio emission with a spectral index of 1.30 ± 0.05. The results lend support to a suggestion by Spinrad that these objects are extragalactic. No radio emission was detected from object 1. (auth)

37156 AN INFRARED TEST OF THE DENSE-CORE MODEL OF THE NUCLEI OF SEYFERT GALAXIES. Weymann, R. (Stewart Observatory, Tucson, Ariz.). Astrophys. J.; 161: L21-4(Jul 1970).

The existence of a dense core responsible for producing the broad wings in the Balmer lines of Seyfert galaxies can be tested by observing an abrupt fall-off in the 100-μ region. Cores with $n_e \gtrsim 10^{10}$ cm^{-3} can already be ruled out by ground-based measurements if the core surrounds the infrared source. Absorption of significant amounts of infrared radiation may be important in the energy balance of such dense cores. Confirmation of infrared variability with time scales less than about 3 days would rule out all such models. (auth)

37157 THERMAL INSTABILITIES IN INTERSTELLAR GAS HEATED BY COSMIC RAYS. Goldsmith, D. W. (Univ. of California, Berkeley). Astrophys. J.; 161: 41-54(Jul 1970).

A theoretical study is presented of thermal instabilities in interstellar gas that is heated by cosmic rays. As a result of such instabilities, perturbations within the hot, rarefied intercloud medium can grow in magnitude and cause a transition to a dense, cool gas phase in pressure equilibrium with the intercloud phase. Analytic expressions give a growth rate from the linearized hydrodynamic equations, and a computer program follows the perturbations into the nonlinear regime. The equations of constraint allow for changes in the ionization of the interstellar gas and for the presence of a magnetic-field component perpendicular to the wave vector of the perturbation. Calculations for the equilibrium state at a point near the onset of instability show that typical e-folding times are $\sim 10^7$ years at the start of the perturbation. These times decrease as the disturbances progressively grow farther from the equilibrium state. Times of cloud formation along the magnetic lines of force are $\sim 5 \times 10^7$ years. Since the interstellar gas has essentially infinite conductivity, condensations in a direction perpendicular to the magnetic field increase the field strength in this direction. The magnetic pressure can reduce the growth rate or halt the increase of the perturbation at a lesser density than would be reached in the absence of a magnetic field. The computer program was also used to study a one-dimensional spherical-piston problem as an approximation to the advance of a supernova shell into the initially homogeneous intercloud medium. (auth)

37158 DENSITY WAVES IN A HIGHLY FLATTENED, RAPIDLY ROTATING GALAXY. Vandervoort, Peter O. (Univ. of Chicago). Astrophys. J.; 161: 87-102(Jul 1970).

A method is described for the solution of Liouville's equation governing the response of a given subsystem of stars in a galaxy of small but finite thickness when the galaxy is perturbed in a manner which does not distort its plane. The method is an adaptation of the method of solution described in the preceding paper. In particular, it involves the use of the adiabatic invariant whose approximate constancy characterizes the perpendicular motions of stars in the unperturbed galaxy. As an illustration and application of the method, the propagation of density waves in a rapidly rotating galaxy of finite thickness is investigated in detail. Poisson's equation governing the perturbed gravitational field is reduced with the aid of the solution of Liouville's equation to a certain characteristic-value problem which determines the dispersion relation for the waves; and that problem is solved with the aid of a variational principle. For practical applications, the dispersion relation obtained does not differ significantly from the dispersion relation derived by Shu on the basis of a heuristic treatment of the perpendicular structure of the perturbed galaxy. (auth)

37159 THE EQUILIBRIA OF A HIGHLY FLATTENED, RAPIDLY ROTATING GALAXY. Vandervoort, Peter O. (Univ. of Chicago). Astrophys. J.; 161: 67-86(Jul 1970).

In a highly flattened galaxy a typical star oscillates in the direction perpendicular to the plane about which the mass of the system is concentrated with a frequency which is large compared with the other frequencies of its motion. A method of solving Liouville's equation in an approximation appropriate to this condition is described. An explicit solution for the distribution function is obtained by this method for a subsystem of stars in a rapidly rotating, axisymmetric galaxy in equilibrium. The construction of this solution involves a further approximation based on the circumstance that the orbits of typical stars depart only slightly from circular orbits. With the density determined by this solution for the distribution function, Poisson's equation is solved for a certain family of equilibrium configurations. This family of equilibrium configurations is made the basis for the construction of a dynamical model of the Galaxy. (auth)

Cosmology

Refer also to abstracts 37915 and 37918.

37160 (N-70-18890) PREDICTED HIGH-ENERGY BREAK IN THE ISOTROPIC GAMMA-RAY SPECTRUM: A TEST OF COSMOLOGICAL ORIGIN. Fazio, G. G.; Stecker, F. W. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Jan 1970. 10p. (NASA-TM-X-63818; X-641-70-26). CFSTI.

A critical test of the cosmological pion-decay hypothesis for the origin of the isotropic gamma radiation above 1 MeV is pointed out, and a high-energy break in this component is predicted. The test lies in the detection of a break in the gamma-ray energy spectrum due to interactions of these gamma rays with the universal blackbody radiation at large redshifts. (auth) (STAR)

37161 COSMOLOGICAL RED SHIFT. Bellert, Stanislaw (Technical Univ., Warsaw). Astrophys. Space Sci.; 7: 211-30(May 1970).

The author's hypothesis (Astrophys. Space Sci., 3: 268 (1969)) which explains the red shift in terms of a geometry of static space and stationary observers is extended. The notions of "metric with an observer," "observed distance," and "space of observations" are introduced and the problem of the equivalence of stationary observers is considered. The relation between the hypothesis, the special theory of relativity, and Maxwell equations is discussed. Attention is drawn to the agreement between the hypothesis and the experimental results discussed by Shamir and Fox, and those discussed by Kennedy and Thorndike. (auth)

37162 QUASARS AND HIGH-ENERGY ASTRONOMY. Including the Proceedings of the Second Texas Symposium on Relativistic Astrophysics, Austin, Texas, December 15–19, 1964. Douglas, K. N.; Robinson, Ivor; Schild, Alfred; Schucking, E. L.; Wheeler, J. A.; Woolf, N. J. (eds.). New York; Gordon and Breach, Science Publishers, Inc. (1969). 498p. $49.50. (CONF-641214).

The second symposium continued the discussion of quasi-stellar sources and reported on the progress made in the preceding year. Half of the symposium was devoted to the new maps of the sky, to x-ray, γ-ray, and cosmic-ray astronomy, to the search for cosmic neutrinos and to the possible large-scale implications of the breakdown of CP invariance. Scissions were presented on radio observations of radio galaxies and quasars, optical observations and models for quasars and radio galaxies, cosmic rays, x- and γ-ray astronomy, neutrino astronomy, and gravitational collapse. Most of the papers have appeared in the literature. (W.D.M.)

37163 SPECTRUM OF PRIMORDIAL RADIATION: ITS DISTORTIONS AND THEIR SIGNIFICANCE. Syunyaev, R. A.; Zeldovich, Ya. B. Comments Astrophys. Space Phys.; 11: 66-74(Mar-Apr 1970).

After some preliminary remarks two principal cases of spectrum distortions are described: (1) energy injection before recombination, at $T > 4000$ °K, and (2) the same recombination, at $T < 4000$ °K. Some applications of the formulae to cosmological problems are shown. (W.D.M.)

37164 DIFFUSE COSMIC X-RAY BACKGROUND RADIATION. Brecher, K.; Burbidge, G. Comments Astrophys. Space Phys.; 11: 75-83(Mar-Apr 1970).

An attempt is made to examine the present state of the observations of the isotropic component of the x- and γ-ray background radiation, the numerous ingenious schemes that have been proposed to explain it, and to discuss what, if any, conclusions can be drawn about the nature of the Universe from the data so far available. (W.D.M.)

37165 POINT MASS IN A EINSTEIN UNIVERSE. Leibovitz, Clement (Univ. of Alberta, Edmonton). Commun. Math. Phys.; 17: 177-8(1970).

An exact solution of Einstein's equations is presented for a perfect fluid representing a point mass in an Einstein Universe. (auth)

37166 STABILITY OF CIRCULAR ORBITS IN STATIONARY, AXISYMMETRIC SPACE-TIMES. Bardeen, James M. (Univ. of Washington, Seattle). Astrophys. J.; 161: 103-9(Jul 1970).

Stability criteria are derived for circular particle orbits in the equatorial plane of a stationary, axisymmetric space-time in general relativity. They are applied to show that the orbits of the particles making up an infinitesimally thin disk are stable as long as the angular momentum per unit mass of the particles increases monotonically outward from the axis of symmetry. (auth)

37167 MACH'S PRINCIPLE, THE KERR METRIC, AND BLACK-HOLE PHYSICS. Godfrey, Brendan B. (Princeton Univ., N. J.). Phys. Rev., D; 1: 2721-5(15 May 1970).

The generalized Kerr solution is tentatively accepted as the description for the state of a charged rotating mass which has undergone complete gravitational collapse. Mass accretion by such a system is demonstrated to damp out the rotation. Even the most favorable selective capture of matter leaves the angular momentum bounded by m^2, precisely the upper limit that the Kerr geometry can accommodate without change of character. Mach's principle, exemplified by the rotation of inertial frames, is employed to obtain approximate expressions for perihelion precession of satellites, deflection of light trajectories, and the rotation of polarization of light. Results are compared with exact expressions, when available. (auth)

37168 FLUCTUATIONS AT THE THRESHOLD OF CLASSICAL COSMOLOGY. Harrison, E. R. (Univ. of Massachusetts, Amherst). Phys. Rev., D; 1: 2726-30(15 May 1970).

The "threshold epoch" of classical cosmology is first discussed from a classical point of view. It is shown that if the density fluctuations at this epoch are proportional to N^{-n} (where N is the number of particles in a disturbance), then n must exactly, or very closely, equal the value $\frac{2}{3}$ in order that such fluctuations develop into protogalaxies. This result is independent of the value of the threshold epoch, and of the equation of state for the very early universe. Arguments of a speculative nature are then presented which indicate that the threshold epoch occurs at the Planck density. It is also proposed that the initial conditions of galaxy formation are metric fluctuations at the threshold epoch of classical cosmology. The evidence in favor of this theory is (i) the density fluctuation obeys the $n = \frac{2}{3}$ rule, and (ii) the spin fluctuation gives an eventual angular momentum of the order $N^{\frac{1}{2}}\hbar$, in reasonable agreement with that of the Galaxy. (auth)

37169 UNIFORM MODEL UNIVERSES CONTAINING MATTER AND BLACKBODY RADIATION. May, T. L.; McVittie, G. C. (Univ. of Illinois, Urbana). Mon. Notic. Roy. Astron. Soc.; 148: 407-16(1970).

Models containing gaseous matter and "background" blackbody radiation are considered. A general method of solving Einstein's equations for such models is set up. It is applied to the elucidation and extension of previous work by McIntosh (1968) and to the discovery of new classes of models. The a priori assumption that the gas pressure is zero is avoided. (auth) (UK)

Planetary Phenomena

37170 PROCEEDINGS OF THE APOLLO 11 LUNAR SCIENCE CONFERENCE, HOUSTON, TEXAS, JANUARY 5-8, 1970. VOLUME 1. MINERALOGY AND PETROLOGY. Levinson, A. A. (ed.). Geochimica et Cosmochimica Acta, Supplement I, 1970. New York; Pergamon Press, Inc. (1970). 1008p. (CONF-700106-(Vol.1)).

Abridged summaries of the papers of this volume as well as those of Vols. 2 and 3 (see next two abstract nos.) were published in the Jan. 30, 1970 issue of Science (Vol. 167, pages 447 to 784). Individual papers considered to be within the scope of NSA appeared in NSA Vol. 24, No. 11. (W.D.M.)

37171 PROCEEDINGS OF THE APOLLO 11 LUNAR SCIENCE CONFERENCE, HOUSTON, TEXAS, JANUARY 5-8, 1970. VOLUME 2. CHEMICAL AND ISOTOPE ANALYSES. Levinson, A. A. (ed.). Geochimica et Cosmochimica Acta, Supplement I, 1970. New York; Pergamon Press, Inc. (1970). 953p. (CONF-700106-(Vol.2)).

37172 PROCEEDINGS OF THE APOLLO 11 LUNAR SCIENCE CONFERENCE, HOUSTON, TEXAS, JANUARY 5-8, 1970. VOLUME 3. PHYSICAL PROPERTIES. Levinson, A. A. (ed.). Geochimica et Cosmochimica Acta, Supplement I, 1970. New York; Pergamon Press, Inc. (1970). 564p. (CONF-700106-(Vol.3)).

37173 FORMATION OF PLANETS. Mitra, V. (MNR Engineering Coll., Allahabad, India). Astron. Astrophys.; 6: 491-3 (Jul 1970).

On the basis of the accretional theory for the formation of the planets as recently developed by the author (Mitra, 1970), the dimensions of the gaseous disc formed in the equatorial plane of the solar nebula were determined. It was concluded that the particle accretion commenced only after the gaseous disc split into separate gaseous rings and that this splitting took place in two distinct groups. (auth)

37174 MULTIPLE SCATTERING IN A PLANE-PARALLEL ATMOSPHERE. II. CURVES OF GROWTH FOR REFLECTION SPECTRA. Uesugi, Akira; Irvine, William M. (Univ. of Massachusetts, Amherst). Astrophys. J.; 161: 243-54(Jul 1970).

Basic formulae are derived for the computation of the line profile and equivalent width of an absorption line formed by reflection from a thick planetary atmosphere for an arbitrary single-scattering phase function. The method of successive scattering (Neumann series) is used; rapid convergence is achieved even for conservative scattering through use of an asymptotic expression valid for large orders of scattering. Limiting formulae valid for very weak and very strong lines, and for large and small continuum absorption, are obtained. The formulae are applied to the case of a Lorentz line profile, and numerical results are obtained for isotropic scattering. (auth)

37175 LUNAR ATMOSPHERE AS A SOURCE OF ^{40}Ar AND OTHER LUNAR SURFACE ELEMENTS. Manka, R. H. (Manned Spacecraft Center, Houston, Tex.); Michel, F. C. Science; 169: 278-80(17 Jul 1970).

The lunar atmosphere is the likely source of excess ^{40}Ar in lunar surface material; about 8.5% of the ^{40}Ar released into the lunar atmosphere will be implanted in the surface material by photoionization and subsequent interaction with fields in the solar wind. The atmosphere is also likely to be the source of other unexpected surface elements or of solar-wind elements that impact from non-solar wind directions. (auth)

37176 REACTION OF CARBON AND SULPHUR ISOTOPES IN APOLLO 11 SAMPLES WITH SOLAR HYDROGEN ATOMS. Berger, R. (Univ. of California, Los Angeles). Nature (London); 226: 738-9(23 May 1970).

It has been observed that the lunar fines are significantly enriched in ^{13}C and ^{34}S compared with the fine grained basaltic rocks of the Apollo II landing site, and it has been suggested that this may be due to removal of lighter isotopes (^{12}C and ^{32}S) from the unshielded lunar surface by the action of hydrogen from the solar wind. The mechanism of removal is thought to involve the conversion of ^{12}C and ^{32}S into $^{12}CH_4$ and $H_2{}^{32}S$, which are subsequently lost from the Moon. On the other hand, the solar wind may actually deposit isotopically heavier C on the lunar surface, which might account for the observed enrichment in the lunar fines. A second process for the deposition of C on the lunar surface might be the addition of carbonaceous chondrite-like material to the lunar soil. These alternative processes are discussed. It is concluded that several processes appear to occur on the Moon that are capable of producing a heavier isotopic composition of C and S in finely divided soil relative to solid rock. It would be useful to measure the C content and isotopic composition of fines in the polar regions of the Moon and compare with measurements from the sunlit areas. If C from the poles were isotopically lighter compared with the Sun-exposed region, then solar wind erosion would be proven. (UK)

Atomic and Molecular Physics

Atomic, Electron, Ion, and Molecular Beams and Their Reactions

Refer also to abstract 36265.

37177 (NYO-2962-8) THE INTERACTION OF RADIATION WITH MATTER. Progress Report, February 1, 1970-January 31,

1971. Brandt, Werner; Pope, Martin (New York Univ., N. Y. Radiation and Solid State Lab.). Nov 1969. 99p. Dep. CFSTI.

ALUMINUM — ionization by light and heavy ions, cross sections for K-shell, (E/T)
ANTHRACENE — ionization efficiency of photons in, effects of electric field on
— electronic transitions in, calculations of σ-π^*
BENZENE — energy transfer to fluorescent solute, effects of chloroform on
CHLOROFORM — effects on fluorescence energy transfer in benzene and o-xylene, quenching
COPPER — proton dechanneling in crystals of
ELECTRIC FIELDS — effects on ionization efficiency of photons in anthracene
HELIUM ISOTOPES He-3 — reactions with aluminum at 20 to 200 keV, K-shell ionization cross sections for, (E/T)
HELIUM ISOTOPES He-4 — reactions with aluminum at 20 to 200 keV, K-shell ionization cross sections for, (E/T)
IONIZATION — cross sections for K-shell, (E/T)
MAGNETIC FIELDS — effects on excitons in naphthacene
NAPHTHACENE — exciton dynamics in fluorescence of, effects of magnetic field on
NAPTHALENE — electronic transitions in, calculations of σ-π^*
NEON — spectra of Pauli-excited, beam-foil, (E)
POSITRONIUM — yield in gases and organic solids, effects of subexcitation Ore gap and electric field on, (E/T)
POSITRONS — lifetime in sodium chloride crystals, effects of irradiation and deformation on, (E)
— annihilation in quartz, angular correlation of gammas from, (E)
PROTONS — reactions with aluminum at 20 to 200 keV, K-shell ionization cross sections for, (E/T)
— dechanneling in copper crystals
— channeling in sodium chloride crystals, x-ray production in, (E)
QUARTZ — positron annihilation in, angular correlation of gammas from, (E)
RADIATION DETECTORS, SEMICONDUCTOR (SILICON) — response to heavy ions, (E)
SODIUM — spectra of Pauli-excited, beam-foil, (E)
SODIUM CHLORIDES — x-ray production by proton channeling in crystals of, (E)
— positron annihilation in crystals of, effects of radioinduced defects and deformation on, (E)
X RADIATION — effects on positron annihilation in sodium chloride crystals, (E)
o-XYLENE — energy transfer to fluorescent solute, effects of chloroform on (D.L.C.)

37178 (ORNL-TM-2981) MULTIPLY CHARGED HEAVY IONS PRODUCED IN A HOT ELECTRON PLASMA. Alexeff, I.; Jones, W. D.; Neidigh, R. V. (Oak Ridge National Lab., Tenn.). 30 Apr 1970. Contract W-7405-eng-26. 20p. Dep. CFSTI.

Multiply charged argon-ion beams of sufficient intensity to be of interest as sources for heavy-ion accelerators were produced, using the ORNL Mode II hot-electron plasma. Quantitative analysis of the first five charge states suggests that the dominant generation mechanism is the single-impact ionization process for which yields have recently been estimated by Postma. (auth)

37179 OBSERVED INTENSITY AND SPEED DISTRIBUTIONS OF THERMAL-ENERGY ARGON ATOMS SCATTERED FROM THE (111) FACE OF SILVER. Bishara, M. N.; Fisher, S. S. (Univ. of Virginia, Charlottesville). J. Chem. Phys.; 52: 5661-75(1 Jun 1970).

The scattering of thermal-energy monatomic gases from metal surfaces is studied using the Ar–Ag system. The argon atoms are incident to the surface in the form of nearly monoenergetic beams from a gas-dynamic nozzle source. The target surface is the polished (111) face of a monocrystalline silver disk. In studying this interaction, essentially complete maps of the relative intensities and speeds of the scattered atoms are obtained using a time-of-flight method. The argon beams have energies ranging from 0.06 to 0.17 eV and are incident at angles varying from 40° to 60° from the target normal. The surface temperature ranges from 550 to 790°K. Because of surface roughness, approximately 80% of the incident atoms are scattered diffusely while the remainder are scattered into a crest-shaped lobe centered subspecularly within the plane of incidence. To a first approximation, it is shown that the speed distributions of the diffusely scattered components are independent of scattering angle and that they are nearly Maxwellian in form and exhibit mean speeds corresponding to high thermal accommodation to the surface. The lobularly scattered atoms show a clear tendency to conserve their momentum tangential to the surface. Moreover, it appears that the characteristics of the two component beams are relatively independent of the fraction scattered into each. General properties of the scattered beams are discussed and comparisons with applicable studies are offered. (auth)

37180 ATOMIC-BEAM FOCUSING IN A HEXAPOLE MAGNETIC SYSTEM WITH SPHERICAL ABERRATION. Trotsyuk, N. I. (Kiev Polytechnical Inst.). Sov. Phys.-Tech. Phys. (Engl. Transl.); 14: 529-34(Oct 1969).

Translated from Zh. Tekh. Fiz.; 39: 704-12(Apr 1969).

A study is made of the influence of spherical aberration on focusing of a beam of atoms with constant effective magnetic dipole moment in a two-dimensional magnetic field with three planes of symmetry and three planes of antisymmetry. The position of minimum beam section is found and the radius of this section is determined for a beam from a point source and for a beam entering the magnetic field parallel to the axis of the magnetic system. (auth)

37181 SIGNAL-TO-NOISE RATIOS FOR ION AND METASTABLE DETECTION OF NEUTRAL MOLECULAR BEAMS. Singh, R. (Univ. of California, Berkeley). Rev. Sci. Instrum.; 41: 1092(Jul 1970).

The main source of noise in molecular beam detection is discussed, and a simple formula for estimating the signal-to-noise ratio is given. (W.H.K.)

37182 ENERGY LOSSES IN A HIGH-POWER ELECTRON BEAM. Beilis, I. I.; Rakhovskii, V. I.; Tkachev, L. G.; Smelyanskii, M. Ya. (Moscow Order of Lenin Power Inst.). Sov. Phys.-Tech. Phys. (Engl. Transl.); 14: 1237-42(Mar 1970).

Translated from Zh. Tekh. Fiz.; 39: 1650-7(Sep 1969).

The thermal balance in a metal surface bombarded by a powerful beam of electrons with energies ranging from 20 to 40 keV was studied. Partial reflection of beam electrons from the metal surface is discussed, and experimentally derived values of the power carried off by the reflected electrons are given. Certain processes involving the interaction of beam electrons with the residual gas and metal vapor are discussed; the anomalously high energy loss observed when the beam traverses the gas and metal vapor is discussed in terms of coherent interaction between the beam and the plasma excited by the beam. Results of calorimetric measurements of beam energy losses suffered as the beam traversed a layer of the gas are also given. (auth)

37183 SCATTERING CROSS-SECTION MEASUREMENTS FOR EPITHERMAL Ar ON Ag(111) SURFACES. Calia, Vincent S.; Oman, Richard A. (Grumman Aerospace Corp., Bethpage, N. Y.). J. Chem. Phys.; 52: 6184-8(15 Jun 1970).

A series of measurements of scattering cross sections were made for nearly monoenergetic beams of argon on epitaxial (111) films of silver. Quantitative determinations of the fraction of the incident flow that exits in each solid angle element are compared directly with Oman's calculations for exactly matched situations. Nominal incident energies of 1 and 2 eV were provided by a shock-tube-driven, high-intensity molecular beam. The measurements were made both in and out of the plane of incidence, so that a stringent test of the calculations is possible. Agreement was unexpectedly good, further confirming the validity of the calculation method as indicated by earlier agreement with the data of Romney and Anderson as well as those of Miller and Subbarao. (auth)

37184 ANALYTIC METHODS FOR THE ION MICROPROBE MASS ANALYZER. PART II. Andersen, C. A. (Hasler Research Center, Goleta, Calif.). J. Mass Spectrom. Ion Phys.; 3: 413-28(Mar 1970).

Positive and negative sputtered ion yields from pure elements and from compounds bombarded with high energy beams of reactive gases are presented. The yields are shown to be related to sputtered atom yields and can be calculated according to a simple model proposed by Rol et al. with a modified interaction potential. The parameter k of this model is evaluated in terms of the full-plane threshold energy. Methods for calculating the threshold energy and the binding energy of an atom to the surface of the target are proposed. Positive sputtered ion yields are shown to be inversely related to the electron availability at the surface as governed by the surface barrier and the Fermi distribution of electrons. Positive ion yields are enhanced and controlled by reducing electron availability through bombardment with electronegative gases. Negative sputtered ion yields are shown to be directly related to the availability of surface electrons and are governed by the work function of the surface and the electron affinity of the sputtered atom. Negative ion yields are enhanced and controlled by increasing electron availability through bombardment with electropositive gases. (auth)

37185 RANGE-ENERGY RELATION IN HELIUM. Derrick, M. (Argonne National Lab., Ill.); Fields, T.; Hyman, L. G.; Keyes, G.; Fetkovich, J.; McKenzie, J.; Wang, I. T. Phys. Rev., A; 2: 7-13(Jul 1970).

The mean excitation potential of helium was determined to be 42.7 ± 0.6 eV by measuring the ranges of monoenergetic particles in a helium bubble chamber. Special care was taken to minimize systematic errors in the measurement of track lengths. The result obtained is independent of assumed corrections to the Bethe–Block equation at low velocity, but a discussion of such corrections is presented. Two existing theoretical estimates of 41.5 and 41.8 eV are in fair agreement with the measured value. (auth)

37186 EXCITATION OF Al K AND Hf M X-RAY LINES BY 70 TO 400-keV H^+, He^{++}, N^{++}, O^{++}, AND Ar^{++} IONS. Needham, P. B. Jr.; Sartwell, B. D. (College Park Metallurgy Research Center, Md.). Phys. Rev., A; 2: 27-9(Jul 1970).

The K shell of aluminum and the M shell of hafnium were excited using H, He, N, O, and Ar ions in the energy range 70 to 400 keV. The appearance of an excitation mechanism is observed for N, O, and Ar projectiles, which results in ionization cross sections several orders of magnitude greater than those predicted by a direct-scattering interaction such as is assumed for H and He ions. The results are examined in the light of the electron promotion mechanism of molecular-orbital theory as suggested by Der et al. The similar increases in cross sections for the hafnium M shell and the aluminum K shell using incident ions heavier than He suggest that an electron promotion mechanism does not provide a satisfactory explanation of the anomalous cross sections. It is felt that other factors, such as polarization of the relevant atomic shells of both the target atom and the projectile at close impact distances, must be considered in terms of the direct-scattering theory. (auth)

Atomic and Molecular Properties

Refer also to abstracts 37013, 37113, 37114, 37576, and 37597.

37187 (COO–1120–100) A TABLE OF EO CONVERSION PROBABILITY ELECTRONIC FACTORS. Bell, D. A.; Aveledo, C.; Davidson, J. P.; Davidson, M. G. (Kansas Univ., Lawrence. Nuclear Physics Lab.). [30 Jan 1970]. Contract AT(11-1)-1120. 55p. Dep. CFSTI.

The electronic factors of the electric monopole conversion probabilities as a function of the atomic charge number Z and transition energy k for K, L_I, and L_{II} shells are presented in tabular form. The table lists factors over a range of k/mc^2 from 0.1 to 5.0 units in increments of 0.1 units and from Z = 40 to 102 in steps of ΔZ = 2. The factors are calculated relativistically and include corrections for finite nuclear size and bound-state atomic screening. (auth)

37188 (NBS-SPEC. PUBL–306-3) BIBLIOGRAPHY ON THE ANALYSES OF OPTICAL ATOMIC SPECTRA. SECTION 3. Mo–La; Hf–Ac. Moore, Charlotte E. (National Bureau of Standards, Washington, D. C.). May 1969. 37p. GPO $0.50.

References needed to revise and extend previously published tables of atomic energy levels (NBS Circ. 467, Vol. III (1958)) are presented. The papers refer mostly to laboratory observations and analyses. A few papers on observations of coronal or nebular spectra and a few papers on theoretical work are included. (A.G.W.)

37189 (UCRL–19520) ATOMIC BEAM MEASUREMENT OF THE ^{39} ^{41} ^{42}K ISOTOPE SHIFT. Marrus, Richard; Wang, Edmond C.; Yellin, Joseph (California Univ., Berkeley. Lawrence Radiation Lab.). Dec 1969. Contract W-7405-eng-48. 17p. Dep. CFSTI.

The isotope shifts of ^{41}K and 12.4-hour ^{42}K relative to ^{39}K were studied in the D_1 line ($4^2P_{\frac{1}{2}}$ $\xrightarrow{7699\text{Å}}$ $4^2S_{\frac{1}{2}}$) by the atomic beam method and found to be +7.4 ± 0.3 and +16 ± 4, respectively, in units of 10^{-3} cm^{-1}. (auth)

37190 INTEGRAL TRANSFORM GAUSSIAN WAVE FUNCTION FOR H_2^+. Yue, C. P.; Somorjai, R. L. (National Research Council of Canada, Ottawa). Chem. Phys. Lett.; 5: 537-40(1 Jun 1970).

The ground-state energies of H_2^+ were calculated for the internuclear separations R = 1.0, 1.8, 2.0, 2.2, 3.0, 4.0, and 5.0 a.u. The integral transform gaussian functions $k_n(qr)$ were used as atomic orbitals. The results surpass corresponding results obtained with scaled 1s functions. The equilibrium internuclear separation was found to be at R = 1.97 a.u. with a total energy –0.5896 a.u. (auth)

37191 LEVEL-CROSSING EXPERIMENTS TO INVESTIGATE THE HYPERFINE STRUCTURE AND LIFETIME OF 5d6s6pz $^2F_{\frac{5}{2}, \frac{7}{2}}$ STATES IN THE LANTHANUM I SPECTRUM. Hese, Achim (Technische Univ., Berlin). Z. Phys.; 236: 42-51(1970). (In German).

The hyperfine-structure interaction constants A/g_J and B/g_J of the 5d6s6pz $^2F_{\frac{5}{2}, \frac{7}{2}}$ terms in the La I spectrum were measured by a level-crossing technique. A La atomic beam was used to detect many level crossings between magnetic sublevels with $|\Delta m| = 2$ in both terms by resonance scattering. Values for the lifetime of each state were deduced from the widths of Hanle-effect and level-crossing signals. (auth)

37192 PHOTOELECTRIC EMISSION OF METALS BY X RAYS IN THE keV REGION. Mori, Chizuo; Watanabe, Tamaki (Nagoya Univ., Japan). Jap. J. Appl. Phys.; 9: 666-72(Jun 1970).

Electron emission yield from the metal surface under irradiation by nearly monochromatic x rays covering the energy range from 1.5 to 7.9 keV was measured. The yield was about 10^{-1} for gold and about 10^{-2} for aluminium, depending on the incident x-ray photon energy. The ratio of electrons having an energy more than 30 eV to the electron total depends also on the incident x ray photon energy and on the material. According to the emission yield obtained theoretically, Auger electron emission is dominant when incident x ray photon energy is just above the absorption edge of the material. (auth)

37193 ABSORPTION SPECTRUM OF H_2 IN THE VACUUM-UV REGION. II. RYDBERG SERIES CONVERGING TO THE FIRST SIX VIBRATIONAL LEVELS OF THE H_2^+ GROUND STATE. Takezawa, Sanzo (Air Force Cambridge Research Labs., Bedford, Mass.). J. Chem. Phys.; 52: 5793-9(1 Jun 1970).

The absorption spectrum of H_2 at liquid-nitrogen temperature was further investigated with a 6.65-m vacuum spectrograph in the 800- to 600-Å region. Eleven distinct groups, each consisting of 8 to 30 absorption lines, were observed at wavelengths converging to the levels v = 0 to 5 of the H_2^+ ground state. Evidently these individual groups are Rydberg series. Consideration of l-uncoupling effects permits these series to be assigned as R(0), R(1), and Q(1) series in $np\pi \leftarrow X$ transitions and as R(0) series in $np\sigma \leftarrow X$ transitions. A new value of the ionization energy of H_2, 124418.4 ± 0.6 cm^{-1}, was obtained from Rydberg series converging to the v = 0 level of the H_2^+ ground state. (auth)

37194 RELATIVISTIC BALMER FORMULA INCLUDING RECOIL EFFECTS. Brezin, E.; Itzykson, C.; Zinn-Justin, J. (CEN de Saclay, Gif-sur-Yvette, France). Phys. Rev., D; 1: 2349-55(15 Apr 1970).

It is shown that an approximate summation of the "crossed-ladder" Feynman diagrams for the scattering of two charged particles leads to the formula $s = m_1^2 + m_2^2 + 2m_1m_2[1 + 2^3\alpha^2/(n - \epsilon_j)^2]^{-\frac{1}{2}}$ for the squared mass of bound states. This formula neglects radiative corrections. It includes recoil effects properly, and reduces in the limit of one infinite mass to the corresponding spectrum of a relativistic particle in a static Coulomb potential. In the particular case of positronium, its expansion in powers of α coincides up to order α^4 with the singlet energy levels. In an appendix some properties (gauge invariance, static limit) of this series of graphs are investigated. (auth)

37195 TIME RESOLVED STUDIES OF RARE-GAS MOLECULAR EMISSION IN THE VACUUM ULTRAVIOLET: HELIUM AND ARGON. Michaelson, Robert C.; Smith, Allan Laslett (Yale Univ., New Haven). Chem. Phys. Lett.; 6: 1-4(1 Jul 1970).

Gated photoelectric detection is used to resolve overlapping vacuum-uv emission continua from pulsed rare-gas discharges. The bandlike Ar_2 continuum in the 1074 to 1200 Å region arises from collision-induced emission of the $^3P_2$ metastable state of Ar. (auth)

37196 SIMPLE CALCULATION OF POLARIZABILITIES, HYPERPOLARIZABILITIES, AND MAGNETIC SUSCEPTIBILITIES OF ATOMS AND IONS. Heinrichs, Jean (Univ., Liege). J. Chem. Phys.; 52: 6316-19(15 Jun 1970).

Calculations of polarizabilities and magnetic susceptibility for the ions and atoms of rare-gas structure are presented. They are based on Kirkwood's variational approximation for second-order perturbations and its extension in the case of the hyperpolarizability. The detailed calculations include only the effect of the outermost shell of electrons, which is described by means of simple Slater one-electron orbitals. Except for the lightest atoms and ions, the results are in good agreement with available experimental data. The predicted values of ion hyperpolarizabilities are therefore believed to be reliable. (auth)

37197 AB INITIO SCF–MO–CI CALCULATIONS FOR H^-, H_2, AND H_3^+ USING GAUSSIAN BASIS SETS. Csizmadia, I. G.; Kari, R. E.; Polanyi, J. C.; Roach, A. C.; Robb, M. A. (Univ. of Toronto). J. Chem. Phys.; 52: 6205-11(15 Jun 1970).

Fixed-center Gaussian-type functions (GTF) were used as basis sets in an extensive SCF–MO–CI study on H^-, H_2, and H_3^+. An accurate description requires 4 or 5 s-GTF on each

center, plus at least one set of p-GTF, which are essential for the reproduction of reliable potential curves; d-GTF are, however, of minor importance. A constant p exponent may be used successfully in a wide variety of nuclear configurations. Variational energies of −1.3397 and −1.2765 hartree were calculated for the most stable equilateral and collinear geometries of H_3^+. A potential-energy surface was computed for the reaction $H^+ + H_2$, to an accuracy of about 2 kcal $mole^{-1}$ over its important regions. In the computation of the proton affinities of H^- and H_2, little accuracy was lost when a limited basis set was used in SCF calculations. (auth)

37198 DETERMINATION OF EFFECTIVE ATOMIC CHARGES FROM THE CHEMICAL SHIFTS OF X-RAY EMISSION LINES. Leonhardt, G.; Meisel, A. (Karl-Marx-Univ., Leipzig). J. Chem. Phys.; 52: 6189-98(15 Jun 1970).

The x-ray line shifts obtainable as differences of level shifts from various quantum mechanical calculations using the free-ion model provided values in good agreement with each other at least for the Kα shifts. This justifies the determination of effective atomic charges from experimental x-ray line shifts. The formation of inner holes can be taken into account by using the values of Z + 1 for the charge determination of compounds of the element Z. With the 3d elements the Kβ shift must be considered besides the Kα one because of the opposite effects of missing 3d and 4s electrons. The charges determined for the first time only x-ray spectroscopically — generally between 0.8 and 1.5 — as well as the 3d and 4s orbital populations change in the same manner as the values obtained from MO calculations. In contrast to the situation with the main group elements where the effective charge increases with increasing formal charge, the former decreases for formal charges above 2 with the 3d elements. (auth)

37199 WIDTHS OF THE $K\alpha_1$ AND $K\alpha_2$ X-RAY LINES FOR Z > 50. Nelson, G. C.; John, W.; Saunders, B. G. (Univ. of California, Livermore). Phys. Rev., A; 2: 542-3(Aug 1970).

The $K\alpha_1$ and $K\alpha_2$ x-ray widths previously reported (Phys. Rev., 187: 1(1969)) were revised since it was found that the original assumption that instrumental band widths remained constant with energy was incorrect below 55 keV. The new values, based on newly measured instrumental widths, are in good agreement with semitheoretical values. (A.G.W.)

37200 QUANTUM DEFECT THEORY OF l UNCOUPLING IN H_2 AS AN EXAMPLE OF CHANNEL-INTERACTION TREATMENT. Fano, U. (Univ. of Chicago). Phys. Rev., A; 2: 353-65(Aug 1970).

Formulas are developed, which account for the details of the high-resolution photoabsorption spectrum of H_2 near threshold observed by Herzberg. The treatment illustrates the application of Seaton's multichannel quantum defect method under schematic conditions, and might serve as a basis for further developments. (auth)

37201 HYPERFINE STRUCTURE OF MANY ATOMIC LEVELS OF ^{159}Tb AND THE ^{159}Tb NUCLEAR ELECTRIC-QUADRUPOLE MOMENT. Childs, W. J. (Argonne National Lab., Ill.). Phys. Rev., A; 2: 316-36(Aug 1970).

The hyperfine structure and g_J values of the 17 lowest-lying atomic levels of ^{159}Tb were measured by the atomic-beam magnetic-resonance technique. Two of the three levels studied in the $4f^96s^2$ configuration had not been seen before, and the present work in $4f^85d6s^2$ provides the first hyperfine-structure information obtained for 11 of the 14 levels studied. The results are analyzed in detail by use of the best eigenvectors available and the effective-operator formalism. After making suitable corrections for hfs and Zeeman interactions with neighboring atomic states, values for a number of radial integrals are deduced by treating them as adjustable parameters. The value obtained for the electric-quadrupole moment of the ^{159}Tb nuclear ground state is Q (^{159}Tb) = +1.34 ± 0.11 b, in good agreement with earlier results. This value of Q was corrected for Sternheimer shielding effects in both the 4f and 5d electron shells; it results from least-squares fits to the quadrupole hfs measurements in all 17 atomic states studied in both configurations. (auth)

37202 REMEASUREMENT OF THE $2^2S_{\frac{1}{2}}-2^2P_{\frac{1}{2}}$ SPLITTING IN ATOMIC HYDROGEN. Cosens, B. L.; Vorburger, T. V. (Yale Univ., New Haven). Phys. Rev., A; 2: 16-26(Jul 1970).

A remeasurement of the $2^2S_{\frac{1}{2}}-2^2P_{\frac{1}{2}}$ energy separation in atomic hydrogen was remeasured using an atomic-beam microwave technique. The final result obtained from measurements on four resonances is 9911.173 ± 0.042 MHz. When this is combined with the recent remeasurement by Robiscoe of the $2^2S_{\frac{1}{2}}-2^2P_{\frac{1}{2}}$ energy separation, a value for the fine-structure splitting ΔE and the fine-structure constant α^{-1} = 137.0358(5) is obtained. (auth)

37203 COMMENT ON THE CHARACTERISTIC TIME OF SPONTANEOUS DECAY IN JAYNES'S SEMICLASSICAL RADIATION THEORY. Leiter, Darryl (Boston Coll., Chestnut Hill, Mass.). Phys. Rev., A; 2: 259-62(Jul 1970).

Includes reply by E. T. Jaynes.

In the comment the implication in the fact that, in a semiclassical theory of atomic structure proposed by Jaynes and Crisp, the initial state of an atom plays a critical role in determining its average lifetime in an excited state is examined. In the reply, it is pointed out that development of the semiclassical theory was motivated by a need to devise new experimental tests of the present theory of quantum electrodynamics, and some possible experiments are mentioned briefly. (A.G.W.)

37204 EXPERIMENTS ON THE 2^3P STATE OF HELIUM. II. MEASUREMENTS OF THE ZEEMAN EFFECT. Lewis, S. A.; Pichanick, F. M. J.; Hughes, V. W. (Yale Univ., New Haven). Phys. Rev., A; 2: 86-101(Jul 1970).

A series of Zeeman resonances was measured in the 2^3P state of ^{4}He, using the optical-microwave atomic-beam magnetic-resonance technique. The results were analyzed in terms of relativistic and motional contributions to the Zeeman effect, and are presented in the form of corrected g factors: $g_{S'} = g_S - (76.0 \pm 2.4) \times 10^{-6}$, $g_{L'} = g_L + (3.8 \pm 9.0) \times 10^{-6}$, and an additional factor $g_x = (4.0 \pm 25.0) \times 10^{-6}$. These are compared with theoretical calculations using quasi-hydrogenic radial wave functions, which give $g_{S'} = g_S - (79.9 \pm 3.5) \times 10^{-6}$, $g_{L'} = g_L + (1.1 \pm 1.5) \times 10^{-6}$, and $g_x = -(3.2 \pm 4.4) \times 10^{-6}$. The values of the experimental g factors are $g_S^1 = 2.002\ 243\ 2 \pm 0.000\ 022\ 4$, and $g_L^1 = 0.999\ 867 \pm 0.000\ 009$. The validity of the theory and the consistency of the data are discussed. The experimental results were used to reduce the quoted uncertainty in a previously reported fine-structure measurement. The new result is $E(2^3P_2) - E(2^3P_2) = 2291.196 \pm 0.005$ MHz. (auth)

37205 ATOMIC RADIATION IN A CAVITY. Stehle, P. (Univ., Munich). Phys. Rev., A; 2: 102-6(Jul 1970).

The spontaneous decay of an atom located between two parallel plane mirrors of reflectivity R is calculated using the Weisskopf–Wigner method, both when the two mirrors are very large and when they are small. When the mirrors are large and of high reflectivity, the atom radiates more rapidly than in free space and into the Fabry–Perot modes of the mirror system. When the mirrors are small, their effect on the total radiation rate is small, but radiation into the few modes defined is enhanced if the reflectivity is high. It is concluded that the effect of the presence of a laser etalon is insufficient to justify omitting the coupling of the atom to non-Fabry–Perot modes from the Hamiltonian of an atomic system in a laser etalon. (auth)

37206 GRAPHIC ANALYSIS OF PERTURBED RYDBERG SERIES. Lu, K. T.; Fano, U. (Univ. of Chicago). Phys. Rev., A; 2: 81-6(Jul 1970).

A method of analysis of all level positions in multiple strongly perturbed series of levels is presented and illustrated by examples from the rare gas and Ba spectra. The method is suggested by Seaton's multichannel quantum defect theory but is presented here as an empirical approach. It emphasizes the dependence of a perturbation on the periodicity of the perturbing series and aims at extracting significant information from experimental data in compact form; this goal will be pursued in later works. (auth)

37207 POLARIZATION MODEL FOR THE EXCITED STATES OF NEUTRAL HELIUM. Deutsch, C. (Faculte des Sciences, Paris). Phys. Rev., A; 2: 43-9(Jul 1970).

The polarization model for the excited states of He I is reconsidered in the framework of modern perturbation theory. The central potential exerted on the optical electron by the ionic core is obtained in a unified way, and its first three terms — Coulomb, dipole, and quadrupole — are shown to account quantitatively for the binding energy of the excited levels (n,l) with $n \geq 3$ and $l \geq 2$. The usual dipole approximation is then established on firm grounds and appears to be sufficient for practical uses of the polarization model. (auth)

37208 PADE APPROXIMANTS AND INNER PROJECTIONS IN THE BRILLOUIN–WIGNER PERTURBATION SCHEME FOR He-LIKE IONS. Bendazzoli, G. L.; Goscinski, O.; Orlandi, G. (Univ. of Uppsala). Phys. Rev., A; 2: 2-7(Jul 1970).

The continued-fraction expansions in terms of Brillouin–Wigner perturbation energies are evaluated for the He-like series. They show remarkable convergence and stability properties. Both Padé approximants and perturbation energies are computed with formulas derived by the inner-projection technique. (auth)

37209 MULTIPLE-QUANTUM TRANSITIONS IN A ROTATING MAGNETIC FIELD. Phillips, E. A.; Koh, T. K. (Princeton Univ., N. J.). Phys. Rev., A; 2: 263-6(Jul 1970).

The multiple-quantum and rotating-field descriptions of resonant transitions requiring two frequencies are compared. Transitions combining features of both descriptions were observed in experiments using ^{39}K. (auth)

Positronium, Muonium, and Mesic Atoms and Molecules

Refer also to abstracts 37194 and 38313.

37210 TEMPERATURE AND PHASE DEPENDENCE OF POSITRON LIFETIMES IN CHOLINE CHLORIDE. Wang, Cherngmaw; Ache, Hans J. (Virginia Polytechnic Inst., Blacksburg). J. Chem. Phys.; 52: 5492-3(15 May 1970).

The positron annihilation process in choline chloride was studied in the region of its transition from an orthorhombic to a disordered cubic form at temperatures of 73 to 80°C. The lifetime spectra, as measured by standard delayed coincidence techniques, were decomposed into two components. The short-lifetime component was found to be almost independent of temperature, rising from about 0.36 nsec at −196°C to about 0.38 nsec at 150°C. The lifetime of the long-lived component remains fairly constant at temperatures up to 0°C, increases slowly in the range 0 to 50°C, and rises steeply between 70 and 80°C in the region of the known phase transition. The possible relation of these results to density changes and to crystal disorder is discussed. (A.G.W.)

37211 LIFETIMES OF POSITRONS IN ALKALI HALIDES. Garg, J. C.; Saraf, B. L. (Univ. of Rajasthan, Jaipur, India). Chem. Phys. Lett.; 5: 591-2(15 Jun 1970).

Positron lifetimes in alkali metal halides are calculated assuming the outer-shell electrons of the halide ion to form an "electron plasma" capable of concentrating around the positron. The calculated annihilation rates are found to be in good agreement with the experimental results. (auth)

37212 ANGULAR CORRELATION OF POSITRON ANNIHILATION RADIATION FROM ELECTRON-IRRADIATED PLATINUM AND PLASTICALLY DEFORMED PLATINUM. Kusmiss, J. H. (Western Michigan Univ., Kalamazoo); Esseltine, C. D.; Snead, C. L. Jr.; Goland, A. N. Phys. Lett., A; 32: 175-6(9 Jun 1970).

The angular correlation of the positron annihilation radiation from Pt samples that were either irradiated with 2.5-MeV electrons or plastically deformed was measured. Either type of treatment produces changes in the angular correlation that are qualitatively similar. (auth)

37213 POSITRON ANNIHILATION AND THE POSITRON–ELECTRON MANY-BODY SYSTEM. Arponen, Jouko (NORDITA, Copenhagen). Ann. Acad. Sci. Fenn., Ser. A VI; No. 336, 1-43 (1970).

A brief survey of recent experimental and theoretical investigations of the positron behavior in condensed matter is given. The basic but yet uncompletely solved many-body problem of one positron in a homogeneous electron gas of arbitrary density is treated in some detail. Various schemes of approximations to the positron annihilation probability, effective mass, and other properties are discussed, emphasizing their degree of physical feasibility and mathematical rigor. The convergence properties of series developments based on perturbation theory are studied and applied in the present many-body system. An explicit example is given about making a divergent series meaningful by inclusion of a "minimal" set of additional diagrams that yield a correct analytic behavior in the interaction coupling constant. (auth) (Finland)

37214 AN APPROXIMATION FOR POSITRON GREEN'S FUNCTION AND THE POSITRON ANNIHILATION PROBABILITY IN ELECTRON GAS. Arponen, Jouko (NORDITA, Copenhagen). Ann. Acad. Sci. Fenn., Ser. A VI; No. 337, 1-12(1970).

The positron Green's function in an electron gas is studied by performing a ladder-type self-energy summation in which the unscreened Coulomb interaction is used between the electron and the positron. The approximation leads to chemical potential $\mu^+ = -13.3$ eV and total positron annihilation rate $\lambda = 1.95 \times 10^9$ sec^{-1} at electron density $r_s = 6$, and $\mu^+ = -8.5$ eV, $\lambda = 1.99 \times 10^9$ sec^{-1} at $r_s = 10$. (auth) (Finland)

Collision Phenomena

Refer also to abstracts 37095, 37588, and 38070.

37215 (AD-690070) IONIZATION OF HIGHLY CHARGED POSITIVE IONS. Research Communication No. 90. Schwartz, Sanford B.; Bely, Oleg (McDonnell Douglas Corp., Huntington Beach, Calif. Douglas Advanced Research Labs. Observatoire de Nice (France)). Jan 1969. 25p. CFSTI.

Theoretical results are given for the ionization of highly ionized ions having one or two open shells before the collision. Approximate sum and selection rules are obtained. Results are presented for the ionization of Fe XIV by electron impact. The corresponding rates are given for temperatures up to 4,000,000 K. (auth) (USGRDR)

37216 (CALT-767-P-4-61) INTERACTION OF LOW-ENERGY ELECTRONS WITH MOLECULES. Kuppermann, Aron (California Inst. of Tech., Pasadena. Gates and Crellin Labs. of Chemistry). [1970]. 14p. (CONF-700610-3). Dep. CFSTI.

From 4th International Congress of Radiation Research, Evian, France.

Electronic excitation processes occurring when electrons collide with molecules at energies ranging from threshold to about 30 eV above threshold are reviewed. The discussion is divided into a section on processes at less than 1 eV above threshold, in which resonant processes are important, and a section on processes at more than 1 eV above threshold. Both experimental and theoretical techniques appropriate for each energy range are considered. 21 references. (A.G.W.)

37217 (N-70-15044) DETERMINATION OF ENERGY-LOSS FACTORS FOR SLOW ELECTRONS IN HOT GASES. Final Report, April 28, 1968–August 15, 1969. Demetriades, S. T.; Maxwell, C. D. (STD Research Corp., Pasadena, Calif.). Contract NAS2-3580. 162p. (NASA-CR-73400; STD-69-1). CFSTI.

The energy-loss factor for slow electrons of essentially Maxwellian energy distribution was determined in a number of pure gases and gas mixtures as a function of electron temperature and gas enthalpy. The method used to make these measurements employed a high-frequency (2.45 GHz) electric field to elevate the temperature of the free electrons above the temperature of the arc-heated gas and a Langmuir probe to determine the electron temperature. Electron energy-loss factors were obtained for pure argon, helium, and nitrogen and binary mixtures of nitrogen, oxygen, carbon monoxide, carbon dioxide, nitric oxide, and helium with argon. The mixture results were analyzed by means of a single mixture rule and the energy-loss factors for the pure constituent gases were derived. (auth) (STAR)

37218 (N-70-21219) EMISSION CROSS SECTIONS OF N_2 IN THE VACUUM ULTRAVIOLET BY ELECTRON IMPACT. Ajello, Joseph Michael (Colorado Univ., Boulder. Dept. of Astro-Geophysics). 1969. 309p. (NASA-CR-109122). CFSTI.

An electron-beam excitation chamber was designed and constructed for the measurement of emission cross sections by electron-impact excitation of gases. The electron-beam excitation spectrum of N_2 at low pressure in the wavelength range 1200 to 2000 Å was recorded for monoenergetic electron-impact energies from 10 to 208 eV. The spectral features observed were the Lyman–Birge–Hopfield vibrational transitions and several atomic nitrogen lines produced by dissociative excitation of N_2. The emission cross sections of the vibrational transitions of molecular nitrogen were measured. These cross sections were summed to give total emission cross sections for each of the first seven vibrational levels and for the total electronic transition. The results of the experiment were applied to the photoelectron excited dayglow and to the aurora to determine emission rate factors. (auth) (STAR)

37219 (ORO-2911-12) THE INTERACTION OF HEAVY keV IONS WITH GASES. Progress Report and Summary Report. Report No. AEEP-3930-107-7OU. Boring, John W. (Virginia Univ., Charlottesville. Research Labs. for the Engineering Sciences). Jun 1970. Contract AT(40-1)-2911. 29p. Dep. CFSTI.

Work during the period on differential scattering cross sections for light ions colliding with rare gases and on measurement of the total ionization by keV ions in argon mixtures is reported. Some preliminary results for scattering of protons by argon and krypton at 2 to 5 keV are included. Theoretical work on stopping cross sections and on calculation of differential inelastic scattering cross sections is also outlined. Some results showing the value of the nuclear stopping cross section for protons in Ar obtained using different interaction potentials are given. A brief summary of work on this program from its beginning in 1961 to the present and plans for the near future are included. (A.G.W.)

37220 (ORO-3027-16) THE EXCITATION AND IONIZATION OF IONS BY ELECTRON IMPACT. Technical Progress Report, September 1, 1969–May 31, 1970. Hooper, J. W.; Feeney, R. K.; Majure, J. C.; McPherson, D.; Pace, M. O. (Georgia Inst. of Tech., Atlanta. School of Electrical Engineering). Contract AT(40-1)-3027. 27p. Dep. CFSTI.

The status of work on four experimental programs is reported: (1) development of facilities and techniques for determination of electron collision data from magnetoplasma transient response studies; (2) energy loss of singly charged lithium ions upon passage through thin films; (3) determination of absolute cross sections for excitation of Ba^+ ions by electron impact for electron energies near threshold for the processes of interest; and (4) determination of absolute cross sections for ionization of Ba^+ ions by electron impact for electron energies from below threshold to 1000 eV. Progress in equipment preparation and data taking for each program is described briefly; no data are included. (A.G.W.)

37221 NEW METHOD TO STUDY MOLECULES BY ELECTRON IMPACT SPECTROSCOPY. Knoop, F. W. E. (Univ., Leiden); Brongersma, H. H.; Boerboom, A. J. H. Chem. Phys. Lett.; 5: 450-2(1 Jun 1970).

An electron spectrometer was designed for determining electronic energy levels in atoms and molecules by studying energy losses of scattered electrons. A double modulation technique is applied to analyze the energy of the incident and scattered electrons. This enables the measurement of excitation cross sections from zero up to more than 10 eV above the threshold of excitation. The new method is illustrated with helium as the target gas. (auth)

37222 DISTORTED-WAVE BORN SERIES FOR ROTATIONAL INELASTIC SCATTERING. Roberts, R. E.; Ross, John (Massachusetts Inst. of Tech., Cambridge). J. Chem. Phys.; 52: 5011-18(15 May 1970).

The distorted-wave Born series is applied to the problem of rotational inelastic scattering of an atom by a diatomic molecule. The formulation is made in the total angular momentum representation, and for the special but important case of an exponential interaction a simple second-order expression for the degeneracy averaged cross section is derived. Numerical results for two intermolecular potentials compare favorably with exact multistate calculations. The analytic results (1) show that differences between exact and DW results do not vanish near threshold, (2) show the applicability of the method to molecules heavier than H_2, (3) provide a method of assessing the relative order of contributions from various internal states, (4) provide a method of estimating higher-order terms in the DWB series. The application of the second-order DWB series to problems with different forms of potentials of interaction requires only a single numerical integration. (auth)

37223 REACTION OF C^+ WITH CH_4 IN THE 2- TO 200-eV ENERGY RANGE. Wilson, Patricia Sullivan; Rozett, R. W.; Koski, W. S. (Johns Hopkins Univ., Baltimore). J. Chem. Phys.; 52: 5321-4(15 May 1970).

The reaction of $C^+(^2P)$ with CH_4 has been investigated the 2- to 200-eV energy region using a tandem mass spectrometer. All possible ions containing one or two carbon atoms were observed except $C_2H_4^+$. The behavior of the cross sections as a function of the kinetic energy of the incident ion was used to infer reaction mechanisms. Evidence was obtained for the presence of a complex, stripping, and binary collision mechanisms. (auth)

37224 REFINED IMPULSE APPROXIMATION FOR THE COLLISIONAL EXCITATION OF THE CLASSICAL ANHARMONIC OSCILLATOR. Mahan, Bruce H. (Univ. of California, Berkeley). J. Chem. Phys.; 52: 5221-5(15 May 1970).

A modification of the conventional classical theory of vibrational–translational energy exchange is made, which leads to an expression of increased accuracy and which has the proper behavior at high energy. It is pointed out that the refined impulse approximation can be used to calculate the energy transferred to an anharmonic oscillator in configurations where the potential energy curve has positive curvature. The case in which the oscillator potential has negative curvature is analyzed and is shown to lead to energy exchanges that exceed the predictions of the impulse approximation. Expressions are given for the energy transferred in grazing collisions, which can be used to estimate total inelastic cross sections. (auth)

37225 EMISSION OF RADIATION IN THE VACUUM ULTRAVIOLET BY IMPACT OF ELECTRONS ON CARBON MONOXIDE. Aarts, J. F. M.; de Heer, F. J. (FOM-Instituut voor Atoomen Molecuulfysica, Amsterdam). J. Chem. Phys.; 52: 5354-60(15 May 1970).

Relative cross sections were measured for emission of radiation in the vacuum ultraviolet in the case of 0.1- to 5-keV electrons on CO. The molecular transitions studied are the fourth positive band system $A^1\Pi - X^1\Sigma^+$ and the Hopfield–Birge band systems $B^1\Sigma^+ - X^1\Sigma^+$ and $C^1\Sigma^+ - X^1\Sigma^+$. Absolute values for the cross sections are obtained by normalization on those evaluated from inelastic scattering experiments of Lassettre and co-workers. The apparent cross sections for the transitions that combine with the zero vibrational level of $X^1\Sigma^+$ are found to depend strongly on the gas pressure. This is probably caused by trapping of resonance radiation. There are indications in these results, that the electronic transition moment is not constant for the different transitions in the fourth positive band system. Dissociative excitation processes were studied by observation of atomic radiation of fragment atoms and ions. Applications in the intensity calibration in the vacuum ultraviolet wavelength region are discussed. (auth)

37226 REINVESTIGATION OF THE SMALL-ANGLE ELECTRON SCATTERING CROSS SECTION FOR METHANE. Fink, M. (Indiana Univ., Bloomington. Univ. of Texas, Austin); Kohl, D. A.; Bonham, R. A. J. Chem. Phys.; 52: 5487-9(15 May 1970).

The small-angle scattering cross section for methane was measured using 40-keV electrons. The results are compared with other experimental results and with theoretical values calculated using the independent atom approximation with partial wave elastic scattering factors. Possible reasons for the discrepancies are considered. (A.G.W.)

37227 HYDROGEN-ATOM SCATTERING: A DIRECT COMPARISON OF MEASURED AND COMPUTED SCATTERING CROSS SECTIONS FOR MOLECULAR HYDROGEN. Leonas, V. B. (Space Research Inst., Moscow); Pyarnpuu, A. A. Chem. Phys. Lett.; 5: 567-9(15 Jun 1970).

Integral scattering cross sections are calculated and a comparison of the calculated and measured values for the $H-H_2$ system is made. The disagreement found leads to the conclusion that improvement of the short-range part of the known $H-H_2$ semi-empirical potential energy surface is necessary. (auth)

37228 EXCITATION OF Ar I AND He I IN LOW-ENERGY He^+ + Ar COLLISIONS. Isler, R. C.; Nathan, R. D. (Univ. of Florida, Gainesville). Phys. Rev. Lett.; 25: 3-5(6 Jul 1970).

Previous work on investigations of spectral lines emitted from low-energy He^+ + Ar collisions has indicated the presence of emission solely from Ar II. These investigations were extended to show that both Ar I and He I spectra are also present and the relative excitation cross sections for the 7635- and 5876-Å lines of these two species for energies less than 700 eV were measured. (auth)

37229 EXPERIMENTAL EVIDENCE FOR LARGE NONADIABATIC EFFECTS IN CLOSE PROTON COLLISIONS WITH HYDROGEN ATOMS. Bayfield, James E. (Yale Univ., New Haven). Phys. Rev. Lett.; 25: 1-3(6 Jul 1970).

Excitation to the 2s state is important in keV-energy $H^+-H(1s)$ charge-transfer collisions having reduced scattering angles near 3 keV degrees. (auth)

37230 CLASSICAL CALCULATION OF INVERSE BREMSSTRAHLUNG CROSS SECTIONS IN SCREENED POTENTIALS. Gylden, N.; Einarsson, B. (Research Inst. of National Defence, Tumba, Sweden). J. Quant. Spectrosc. Radiative Transfer, 9: 1117-31(Aug. 1969).

The Thomas–Fermi potential was used for calculating atomic cross sections for continuous emission and absorption of radiation. The emission cross section follows a simple scaling law in the atomic number Z. Absorption cross sections are given as a correction factor γ to Kramers' formula. Results are reproduced for Z = 10, 26, 47, and 82 for a number of densities and temperatures. Values of γ far below unity are found for low temperatures. At high temperatures, γ may exceed unity. This result is believed to be caused by the inapplicability of Kramers' approximation in those cases. (auth) (UK)

37231 SCATTERING OF POTASSIUM FROM HALOGEN COMPOUNDS AT HYPERTHERMAL ENERGIES. Kempter, V.; Kneser, Th.; Schlier, Ch. (Univ., Freiburg i. B.). J. Chem. Phys.; 52: 5851-4(1 Jun 1970).

A potassium atomic beam with energies from 0.5 to 12 eV was produced by sputtering. The differential elastic cross sections for scattering from C_6H_{12}, CCl_4, $SiCl_4$, $SnCl_4$, Cl_2, and Br_2 were measured. The known behavior of these systems at thermal energies is reproduced to some extent, but there are distinct differences at higher energies for $SnCl_4$, Cl_2, and Br_2. These may possibly be explained by the onset of nonadiabatic transitions between almost-crossing energy surfaces. (auth)

37232 EFFECTS OF ANISOTROPY IN THE POTENTIAL ON MOLECULAR SCATTERING. Cross, R. J. Jr. (Yale Univ., New Haven). J. Chem. Phys.; 52: 5703-7(1 Jun 1970).

Semiclassical differential scattering cross sections are calculated for anisotropic potentials and averaged over molecular orientation. Both the high-frequency and the low-frequency quantum undulations in the differential cross section are quenched and shifted

in phase by the anisotropy. The degree of quenching is comparable for the two types of undulations. The anisotropy has little effect on the classical differential cross section (excluding the undulations). The primary rainbow is broadened by the anisotropy, and the maximum is decreased and shifted slightly to smaller angles. Several novel features of the scattering from anisotropic potentials are discussed. (auth)

37233 LYMAN-α FLUORESCENCE FROM THE PHOTODISSOCIATION OF H_2. Mentall, J. E.; Gentieu, E. P. (Goddard Space Flight Center, Greenbelt, Md.). J. Chem. Phys.; 52: 5641-5(1 Jun 1970).

Photodissociation and fluorescence cross sections for H_2 were measured from 860 to 700 Å by observing the Lyman-α photons emitted at 90° to an incident photon beam. The photodissociation quantum efficiency was found to be unity from 850 Å to the photoionization threshold at 804 Å and about 10% at shorter wavelengths. By observing the fluorescence radiation as a function of decreasing pressure, it was determined that most of the excited H atoms were formed in the metastable 2s state and that the Lyman-α emission results primarily from collisional quenching. The ratio of the collisional cross section with and without Lyman-α emission was measured for different relative velocities and was found to increase appreciably with increasing velocity. (auth)

37234 COLLISION-INDUCED DISSOCIATION OF MOLECULAR IONS. Cheng, M. H.; Chiang, M.; Gislason, E. A.; Mahan, B. H.; Tsao, C. W.; Werner, A. S. (Univ. of California, Berkeley). J. Chem. Phys.; 52: 5518-25(1 Jun 1970).

Velocity vector distributions of the fragment ion products of the dissociative collisions of O_2^+, N_2^+, NO^+, and N_2O^+ with He were determined, using projectile–target relative kinetic energies one to three times the bond energy of the molecular ion. The most probable dissociation event produces a fragment ion whose velocity is very nearly the same as that of the original projectile ion. Fragment ions also appear at smaller velocities and larger scattering angles, and the importance of these features increases with increasing initial relative energy. Three models for the dissociation are discussed, and it is concluded that a version of the stripping model is most nearly consistent with the data. (auth)

37235 TOTAL YIELD AND ANGULAR DISTRIBUTION OF HIGHLY EXCITED HYDROGEN ATOMS FORMED IN Mg, C_3F_{16}, H_2O, AND H_2 TARGETS. Kingdon, J.; Payne, M. F.; Riviere, A. C. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). J. Phys., B (London); 3: 552-63(Apr 1970).

The population was measured of the highly excited states (n = 10 → 15) in a beam of atoms formed by passing D^+, D_2^+, and H_2^+ ions through Mg, C_3F_{16}, H_2O, and H_2 targets. Ion energies were in the range from 10 to 80 keV. An angular dependence of the population was found both for atomic ions and molecular ions incident on the target. In each case the population increased strongly with angle. The total yield of excited atoms was obtained by integration over all angles and it was found that the total yield in H_2 and C_3F_{16} increased with decreasing energy at the lowest energies (10 keV D^+), whereas the yield from H_2O and Mg targets did not show this effect. Possible reasons for the energy dependence and angular distributions are presented. (auth) (UK)

37236 ROTATIONAL EXCITATION IN MOLECULAR COLLISIONS: A STRONG COUPLING APPROXIMATION. Tsien, Thomas P.; Pack, Russel T. (Brigham Young Univ., Provo, Utah). Chem. Phys. Lett.; 6: 54-6(1 Jul 1970).

A generalization of Takayanagi's fully quantum mechanical strong-coupling approximation for rotationally inelastic collisions, valid for small energy exchange, is discussed and tested numerically on a model problem. The method is computationally very simple, and the results are most encouraging. (auth)

37237 RELATIVISTIC EFFECTS IN HIGH-ENERGY INELASTIC ELECTRON–ATOM COLLISIONS. Yates, Albert C. (Indiana Univ., Bloomington). Chem. Phys. Lett.; 6: 49-53(1 Jul 1970).

In the approximation that electron–electron interactions at high incident electron energies (≈40 keV) may be taken as coulombic, an expression for the integral inelastic cross section for all inelastic collisions is given for the hydrogen atom and is easily generalizable to more complex atoms. The results presented indicate that relativistic effects in the above energy range can amount to upwards of 15% of the nonrelativistic results. For the differential cross sections, it is found that such corrections are most important for small-angle scattering. (auth)

37238 ACCURATE CALCULATION OF RADIATION LENGTHS. Knasel, T. M. (Massachusetts Inst. of Tech., Cambridge). Nucl. Instrum. Methods; 83: 217-20(1970).

Using recent precise calculations of the total cross section for pair production, values for the radiation lengths of elements Z = 2, 6, 13, 29 and 82 are given to an accuracy of 0.1% and for Z = 1, to an accuracy of 0.5%. In addition, a formula is given which predicts the radiation length for any other element $Z \geq 6$ to 1%. The present values represent an improvement over commonly used tables because of the precision of the present prediction, the knowledge of its uncertainty, as well as the extended range of elements included. (auth)

37239 OBSERVATION OF REGULAR OSCILLATIONS OF THE TOTAL CROSS SECTION FOR THE EXCITATION OF Ne RESONANCE LINES IN COLLISIONS WITH Na^+ IONS. Bobashev, S. V. (Ioffe Inst. of Physics and Tech., Leningrad). JETP Lett. (USSR) (Engl. Transl.); 11: 260-2(20 Apr 1970).

Translated from Zh. Eksp. Teor. Fiz. Pis'ma Redaktsiyu; 11: 389-91(20 Apr 1970).

The excitation functions of the resonance lines of the Ne atom (I at 736 Å and II at 744 Å) emitted in the collision of Na^+ ions with Ne atoms were investigated at 0.2 to 11 keV. The excitation functions show regular oscillations, with the positions of the I and II maxima coinciding and being equidistant with respect to V^{-1}. A possible mechanism, involving charge exchange, is proposed for this effect. (D.L.C.)

37240 UNITARIZED BORN APPROXIMATION FOR ROTATIONAL EXCITATION. von Seggern, M.; Toennies, J. P. (Univ., Bonn). Chem. Phys. Lett.; 5: 613-18(15 Jun 1970).

Inelastic cross sections for rotational excitation of N_2 in low-energy collisions with He were calculated using a unitarized Born approximation. In this approximation the violation of the law of conservation of particles is removed from the ordinary Born approximation. A comparison of calculated cross sections with those obtained from the nonunitarized Born approximation and from the nearly exact close-coupling approximation shows that unitarization significantly improves the range of validity of the Born approximation. Useful results are also obtained for indirect transitions that are forbidden before unitarization. (auth)

37241 THEORY OF IONIZATION LOSSES OF FAST ELECTRONS. II. Dolgov, A. S.; Khizhnyak, N. A. (Kharkov Aviation Inst. Moscow Physical-Technical Inst.). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 11, 17-23(1969). (In Russian).

The scattering of fast electrons is considered, taking into account fluctuations of energy losses upon ionization of atoms of the medium. A space–energy function for distribution of electrons is calculated. (tr-auth)

37242 DETECTION OF SINGLY STIMULATED TWO-PHOTON EMISSION FROM METASTABLE DEUTERIUM ATOMS. Braeunlich, P.; Lambropoulos, P. (Bendix Research Labs., Southfield, Mich.). Phys. Rev. Lett.; 25: 135-8(20 Jul 1970).

The observation of singly stimulated two-photon emission from metastable deuterium atoms is reported. A collimated beam of metastables is produced by charge exchange between cesium vapor and 5-keV deuterons. A pulsed Nd-glass laser is used for the stimulation. The generated 1373-Å photons are detected at the exit slit of a spectrometer. Single-photon counting techniques are employed. The results obtained are in good agreement with theoretical calculations. (auth)

37243 ELECTRON TRANSFER FROM O^- TO THE 3p LEVEL OF Na^+ IN 0- TO 7-eV COLLISIONS. Weiner, John; Peatman, William B.; Berry, R. Stephen (Univ. of Chicago). Phys. Rev. Lett.; 25: 79-82(13 Jul 1970).

The cross section for the process $Na^+ + O^- \rightarrow Na(3p) + O$ was determined as a function of relative kinetic energy in the range 0.06 to 7 eV. The measurements were achieved by monitoring the intensity of the Na-D doublet at 5890 Å emitted for the collision region of a merged-ion-beam device. The cross section is extremely large, 10^{-12} to 10^{-11} cm^2, and shows at least one sharp peak, at 2.75 eV. (auth)

37244 POLE CONTRIBUTIONS IN THE DISTORTED WAVE BORN SERIES FOR INELASTIC SCATTERING. Roberts, R. E. (Univ. of Indiana, Bloomington); Ross, John. J. Chem. Phys.; 52: 6446-8(15 Jun 1970).

A simple means of estimating the higher-order contributions to the DWBS for rotationally inelastic encounters of an atom with a diatomic molecule is presented. (A.G.W.)

37245 VIBRATIONAL EXCITATION IN COLLISIONS INVOLVING OXYGEN ION BEAMS. Cosby, P. C.; Moran, T. F. (Georgia Inst. of Tech., Atlanta). J. Chem. Phys.; 52: 6157-65(15 Jun 1970).

Inelastic energy losses in the collisions of O^+ and O_2^+ ions with neutral molecules were studied in a beam apparatus designed to direct mass-analyzed low-energy ion beams onto target molecules and scan the energy, mass, and angular distributions of charged reaction products. Maxima in the scattered ion intensities are

observed in the O^+-O_2 and O_2^+-Ar systems, which are energetically displaced from the centroids of elastically scattered ions by amounts corresponding to known vibrational energy spacings in the respective diatomic species. Vibrational transition probabilities obtained from the inelastic energy-loss data show multiquantum transitions to be more important as the reactant-ion kinetic energy is increased from 10 to 20 eV. For a given reactant-ion kinetic energy, higher vibrational transitions predominate at larger scattering angles. The velocity dependences of these transitions are in reasonable accord with calculations that employ a semiclassical impact-parameter treatment to estimate collisional energy transfer and time-dependent wave functions to evaluate vibrational transition probabilities for a forced harmonic oscillator model. (auth)

37246 COLLISIONAL EXCITATION OF SMALL MOLECULAR IONS. Cheng, M. H.; Chiang, M. H.; Gislason, E. A.; Mahan, B. H.; Tsao, C. W.; Werner, A. S. (Univ. of California, Berkeley). J. Chem. Phys.; 52: 6150-6(15 Jun 1970).

Velocity vector distributions for NO^+ and O_2^+ scattered from helium were determined. As expected, the small-angle scattering is elastic, but at angles greater than 60°, inelasticity that increases with the scattering angle is apparent. For angles greater than 100°, this inelasticity represents vibrational excitation of the molecular ion. For initial relative kinetic energies between 4.3 and 25 eV and 180° scattering, the variation of the inelsticity is consistent with a new, corrected version of the classical theory of vibrational excitation. Three methods of calculating the angular variation of the inelasticity are presented and found to be consistent with the experimental data. (auth)

37247 TOTAL ELASTIC CROSS-SECTION MEASUREMENTS FOR ARGON ON ARGON. Baratz, Bernard; Andres, R. P. (Princeton Univ., N. J.). J. Chem. Phys.; 52: 6145-50(15 Jun 1970).

Total elastic scattering cross sections for argon on argon are presented as a function of the relative velocity of collision. The "glory" extrema predicted to be present as well as the correct velocity dependence for a potential with long-range $1/r^6$ behavior are observed. The data, while not of sufficient quality to be inverted directly, yield constraints on the shape and position of the argon potential well. (auth)

37248 STUDY OF THE TOTAL CROSS SECTION OF AN Ar–Ar SYSTEM AS A FUNCTION OF VELOCITY. Treguier, Jean-Pierre; Hagene, Monique; Pasquerault, Daniele (Rennes Univ., France). Compt. Rend., Ser. B; 270: 1273-6(20 May 1970). (In French).

The total cross section of an Ar–Ar system is studied as a function of velocity. The parameters $C^{(6)}$, ϵ, and r_m are determined. (auth) (France)

37249 DIFFERENTIAL CROSS SECTIONS FOR THE ELASTIC SCATTERING OF 1- TO 95-eV ELECTRONS FROM HELIUM. LaBahn, R. W.; Callaway, Joseph (Louisiana State Univ., Baton Rouge). Phys. Rev., A; 2: 366-9(Aug 1970).

The extended-polarization-potential method was used to calculate the differential cross sections for elastic electron–helium scattering. The results are presented in tabular form for collision energies between 1 and 95 eV and a selection of scattering angles from 0 to 180 deg. Total scattering cross sections are also given for all energies considered. (auth)

37250 MONATOMIC AND DIATOMIC IONS IN OXYGEN. Varney, Robert N. (Lockheed Palo Alto Research Lab., Calif.). Phys. Rev., A; 2: 370-8(Aug 1970).

The reaction rate constants or the cross sections for charge–exchange reactions of the ions O^-, O^+, O_2^-, and O_2^+ with O_2 were measured over a range of values of E/p_0. The rate constant for the O^- exchange rises from 2×10^{-13} cm³/sec at E/p_0 of 25 to 2.7×10^{-10} cm³/sec at E/p_0 of 300 V (cm torr)$^{-1}$. For O^+, the rate constant rises from 1.4×10^{-11} cm³/sec at E/p_0 of 20 to 2.9×10^{-11} at E/p_0 of 55. The resonant charge–exchange cross section for O_2^+ in O_2 is 40 Å², and for O_2^- is 25 Å² at energies of about 0.2 eV. The drift velocities of O^-, O_2^-, and O_2^+ in pure O_2 are also presented. The mobilites for the molecular ions emerge as 2.4 ± 0.1 cm² (V sec)$^{-1}$ for ions of both signs when extrapolated to the limit of E/p_0 of zero, and to p_0 of 760 torr. The values for O^- lie appreciably above those of Eiber and of Beaty. A method of producing relatively large currents of O^- was found. It depends on using higher values of E/p_0 than might be expected from attachment–coefficient data. (auth)

37251 COLLISION SPECTROSCOPY. III. SCATTERING IN LOW-ENERGY CHARGE-TRANSFER COLLISIONS OF He^+ AND Ar. Smith, Felix T. (Stanford Research Inst., Menlo Park, Calif.) Fleischmann, Hans H.; Young, Robin A. Phys. Rev., A; 2: 379-96(Aug 1970).

Differential charge–transfer cross sections σ are measured for He^+ in Ar at energies E from 65 to 300 eV and angles θ from 1° to 30°. The relative measurements are calibrated by comparison with total charge–transfer measurements of Koopman. From reduced plots of $\rho = \theta \sin \theta\sigma(\theta)$ versus $\tau = E\theta$, two, and perhaps three, families of oscillations are identified, with reduced angular thresholds at $E\theta \cong 300$, 970, and 1250 eV deg and with spacing $\Delta\theta$ between peaks near threshold related to the wave number k by the rule $\Delta b = (2\pi/k\Delta\theta) \cong 0.51$, 0.25, and 0.09 a.u., respectively. Using potential curves constructed from earlier information on elastic scattering, the first family is identified as arising from a crossing at 2.9 a.u. to a state dissociating to He ($1s^2$) + Ar^+ ($3s3p^6$), and the second from a crossing at 2.3 a.u. to a state producing He ($1s2s$) + Ar^+ ($3s^23p^5$). Further crossings at distances between 2.25 and 1.95 a.u. leading to other excited–state channels are apparently responsible for more than half of all the charge transfer at these energies. (auth)

37252 DISSOCIATIVE EXCITATION OF SOME OXYGEN-CONTAINING MOLECULES: LIFETIMES AND ELECTRON-IMPACT CROSS SECTIONS. Lawrence, George M. (McDonnell Douglas Corp., Huntington Beach, Calif.). Phys. Rev., A; 2: 397-407(Aug 1970).

Decay lifetimes of seven vacuum ultraviolet O I and O II emission multiplets were measured using a pulsed electron beam in low-pressure samples of O_2, CO, NO, and H_2O. The lifetimes and cascade patterns of the lines are consistent with known autoionization processes. In two cases, spin-orbit-induced autoionization rates are determined. Absolute electron excitation functions for 8447-Å O I were measured in the above gases. Relative excitation functions for 1304-Å O I are normalized to the 8447-Å absolute cross section by means of a time-domain cascade analysis. A method for computing relative cross sections from N-exponential decays is outlined. (auth)

37253 CALCULATION ON IONIZING H-ATOM–H-ATOM COLLISIONS. Omidvar, K.; Kyle, H. Lee (Goddard Space Flight Center, Greenbelt, Md.). Phys. Rev., A; 2: 408-14(Aug 1970).

The Born approximation is used to calculate the cross sections when a hydrogen atom in an excited state with the principal quantum number n collides with a hydrogen atom in the ground state. Calculations are carried out when the first atom is ionized while the second atom has any final state. The cases considered are $n = 1$ to 4. A closure approximation originally used by Lodge is also used here for high impact energy calculations. Disagreement is found with some of Lodge's numerical results. At sufficiently high impact energies, the cross sections are inversely proportional to the energies. Coefficients of proportionalities for all cases are given. When the incident atom is in a state with a high principal quantum number such that the relation $(m/M)\ K^2\alpha_0^3 > n^2 \gg 1$ is satisfied, with the impact energy K^2 in Ry, the electronic and the atomic masses m and M, and the principal quantum number n considered, the cross section is given as $Q_0 = 4(M/m)\ (\ln 4n^2 - \frac{1}{2})\ (\pi\alpha_0^2)\ \mathrm{Ry}/K^2$. (auth)

37254 COMPTON SCATTERING OF X RAYS FROM BOUND ELECTRONS. Eisenberger, P.; Platzman, P. M. (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev., A; 2: 415-23(Aug 1970).

Exact and approximate methods for determining the momentum distribution of electronic systems from Compton scattering measurements are presented. The method used previously to analyze Compton scattering measurements, the impulse approximation (IA), is derived from first principles, and its accuracy is compared with the exact calculations for Compton scattering from a hydrogenic system. It is shown that the IA gives very accurate results for weakly bound electrons and that exact calculation may only be necessary to subtract out the contributions to Compton scattering from deeply bound core electrons. Experimental results for Compton scattering from helium are presented as a test of the above ideas. Analyzing the results of the experiment in the IA gives a momentum distribution for the weakly bound helium electrons in excellent agreement with the momentum distribution obtained from Clementi Hartree–Fock wave functions. (auth)

37255 ELECTRON CAPTURE AND LOSS CROSS SECTIONS OF FAST BROMINE IONS IN GASES. Datz, S. (Oak Ridge National Lab., Tenn.); Lutz, H. O.; Bridwell, L. B.; Moak, C. D.; Betz, H. D.; Ellsworth, L. D. Phys. Rev., A; 2: 430-8(Aug 1970).

Br ions with energies of 13.9 and 25 MeV from the Oak Ridge tandem accelerator were used to measure ionic charge-state distributions in dilute gas targets of H_2, He, and Ar. A least-squares technique was developed to obtain complete sets of electron charge-exchange cross sections from any number and range of measured nonequilibrium charge distributions. Characteristic irregularities, which originate in the atomic shell structure of the Br ions, were

found in the cross sections for capture of a single electron. Multiple electron capture and loss, as well as equilibrium charge distributions, are discussed. (auth)

37256 MEASUREMENTS OF ABSOLUTE CROSS SECTIONS FOR (e,H_2) COLLISION PROCESSES: FORMATION AND DECAY OF H_2^- resonances. Weingartshofer, A.; Ehrhardt, H.; Hermann, V.; Linder, F. (Univ., Mainz). Phys. Rev., A; 2: 294-304(Aug 1970).

Energy and angular dependences of the elastic and inelastic scattering of electrons from H_2 were measured in the energy range 10 to 16 eV and for scattering angles ranging from 10° to 120°. Three resonance series were investigated starting at 11.30, 11.50, and 13.63 eV, respectively. The last two series decay preferentially into one single electronic channel, while the first resonance (resonance I) decays into all energetically possible exit channels, i.e., $X^1\Sigma_g^+$, $b^3\Sigma_u^+$, $B^1\Sigma_u^+$. Throughout, stress is laid on the importance of absolute cross sections and reported values, and excitation functions are presented in absolute units. The cross sections for the elastic channel and some inelastic channels ($X^1\Sigma_g^+$, v = 1 and 2, and the dissociative continuum $b^3\Sigma_u^+$) are composed of resonant and nonresonant scattering and show pronounced and rapidly changing interference structures. Relative branching ratios for resonance series I in terms of absolute total cross sections are listed for those channels where practically no direct scattering amplitude is present. Summarizing those results, one can state that the probabilities (branching ratios) for the decay of resonance series I into the three electronic states $X^1\Sigma_g^+$, $b^3\Sigma_u^+$, and $B^1\Sigma_u^+$ of the H_2 molecule summed over all vibrational states of the exit channel are of the same order of magnitude. From the observed angular dependence of the scattered electrons, the configuration of the resonances was determined and compared with existing theoretical predictions. (auth)

37257 POTENTIAL-SCATTERING MODEL FOR ELECTRONS ON HELIUM AND OTHER ATOMS. Purcell, J. E.; Berg, R. A.; Green, A. E. S. (Univ. of Florida, Gainesville). Phys. Rev., A; 2: 107-11(Jul 1970).

An independent-particle potential-scattering model is proposed for electron scattering by atoms, which is similar in approach to the recent study by Green et al. for bound states of atoms. The general model is discussed, including specific scattering considerations, and specialized to the case of helium. Results of calculations of e–He elastic scattering are given and compared with experimental results and with the calculations by LaBahn and Callaway. By allowing the polarization part of the potential to be slowly energy-dependent, the agreement becomes quite satisfactory. The relevance of this study to future efforts to develop an optical model for elastic electron scattering by atoms and molecules is discussed. (auth)

37258 MODIFIED BORN APPROXIMATION AND THE ELASTIC SCATTERING OF ELECTRONS FROM HELIUM. Ganas, P. S.; Dutta, S. K.; Green, A. E. S. (Univ. of Florida, Gainesville). Phys. Rev., A; 2: 111-18(Jul 1970).

The elastic scattering of electrons from helium atoms is discussed in terms of an energy-dependent central-potential model having the form

$$V(r) = 2Z \lim_{\Lambda\to\mu}\left(\frac{-\Lambda^2}{\Lambda^2-\mu^2}\frac{e^{-\mu r}}{r} + \frac{\mu^2}{\Lambda^2-\mu^2}\frac{e^{-\Lambda r}}{r}\right) - \frac{\alpha}{(r^2+d^2)^2}, \text{ where}$$

μ, α are fixed constants (for He, $\mu = 3.375$ and $\alpha = 1.39$), and d is an energy-dependent phenomenological parameter. The method of partial waves is adapted for a generalized Yukawa potential and a polarization potential. Phase shifts and scattering cross sections are calculated from the potential model using the first Born approximation and a modified form of it. An effective-range theory is developed for a generalized Yukawa and a polarization potential, and it is applied to generate a set of energy-dependent electron–helium phase shifts in the region 0 to 500 eV. Recent experimental angular distribution data in the region 100 to 500 eV are rather satisfactorily accounted for by this potential model. The results compare favorably with those of LaBahn and Callaway. (auth)

37259 TWO-STATE STUECKELBERG–LANDAU–ZENER THEORY APPLIED TO OSCILLATORY INELASTIC TOTAL CROSS SECTIONS. Olson, R. E. (Stanford Research Inst., Menlo Park, Calif.). Phys. Rev., A; 2: 121-6(Jul 1970).

The two-state Stueckelberg–Landau–Zener theory of curve crossings can be utilized to explain qualitatively many of the observed asymmetric-inelastic total cross sections. It predicts not only a broad maximum in the inelastic total cross sections as a function of velocity, but also a rapid rise to this maximum followed by a slow decline past the maximum. If the difference in the potentials between the two states possesses an extremum, oscillations superimposed upon the general velocity dependence of the inelastic total cross sections may also be expected because of the existence of a stationary phase. At high velocities, the spacing of these oscillations will be proportional to v^{-1}. (auth)

37260 TOTAL ELECTRON SCATTERING CROSS SECTIONS IN O_2 AND Ne. Salop, A.; Nakano, H. H. (Lockheed Palo Alto Research Lab., Calif.). Phys. Rev., A; 2: 127-31(Jul 1970).

A modified Ramsauer technique was used to measure the total low-energy scattering cross sections of electrons in O_2 over an energy range from 2.35 to 21 eV, and in Ne over a range from 0.37 to 20 eV. A broad clearly defined "bump" is observed in the e–O_2 cross section with the maximum occurring between 11 and 12 eV. Both the O_2 and Ne cross-section data are in good agreement with Brüche's measurements at energies above 2 eV. Extrapolation of the low-energy Ne data to zero energy, using modified effective-range theory, yields a zero-energy scattering length of $(0.30 \pm 0.03)a_0$, where a_0 is the Bohr radius. (auth)

37261 CROSS SECTIONS FOR POSITIVE-ION AND ELECTRON PRODUCTION IN COLLISIONS OF 1 TO 25-keV HYDROGEN ATOMS WITH ATOMIC AND MOLECULAR GASES. McNeal, R. J.; Clark, D. C.; Klingberg, R. A. (Aerospace Corp., El Segundo, Calif.). Phys. Rev., A; 2: 131-8(Jul 1970).

Cross sections are reported for production of positive ions and electrons in collisions of hydrogen atoms in the energy range 1 to 25 keV with He, Ne, Ar, Kr, Xe, H_2, and O_2. Slow positive ions are produced by capture of an electron by the fast atom from the target gas and by ionization of the target. Electrons are produced by target-gas ionization and by stripping of the fast atom. Ionization cross sections for each of the target gases are derived from the positive-ion production cross sections and previous measurements of the capture cross sections. (auth)

Atomic Theory

Refer also to abstracts 37667 and 38314.

37262 ERROR OF EXPECTATION VALUES FROM THE MC SCF THEORY. Tuan, Debbie Fu-tai (Kent State Univ., Ohio). J. Chem. Phys.; 52: 5247-51(15 May 1970).

It is proved that the expectation values of one-electron operators calculated from multiconfiguration self-consistent-field (MC SCF) wave functions are correct to the order of λ^2, when the accuracy of the wave functions is correct to the order of λ. By using the formalism of Sinanoğlu's many-electron theory of atoms and molecules, it is further shown that only when the MC SCF wave functions include all the nondynamical correlation energies, then the errors of the expectation values for one-electron operators are independent of the specific characters of the operators. This result, in combination with our previous studies of correlation energy of MC SCF theory, suggests a criterion for defining the "best" one-electron model of many-electron atomic and molecular systems. (auth)

37263 SELF-CONSISTENT MOLECULAR ORBITAL METHODS. VI. ENERGY OPTIMIZED GAUSSIAN ATOM ORBITALS. Ditchfield, R.; Hehre, W. J.; Pople, J. A. (Carnegie-Mellon Univ., Pittsburgh). J. Chem. Phys.; 52: 5001-7(15 May 1970).

Minimal basis atomic orbitals expressed as sums of N Gaussian functions are presented for hydrogen and for the first row atoms boron to fluorine. The expansion coefficients and Gaussian exponents are determined by minimizing the total calculated energy of the atomic ground state. For expansion lengths of up to six Gaussians, two sets of atomic orbitals are reported. In the first set, described as unconstrained, different Gaussian exponents are used for the 2s and 2p atomic orbitals. In the second set, the 2s and 2p atomic orbitals are constrained to share the same Gaussian exponents. It is shown that this constraint, which produces a significant gain in computational speed in molecular calculations, does not seriously reduce the quality of the atomic orbitals for given N. A comparison of the contracted sets presented here with previous studies on uncontracted basis sets for the first row atoms, shows that the uncontracted Gaussian exponents are a poor approximation to those of the contracted functions. (auth)

37264 REALIZATION OF THE SYMMETRY GROUPS OF THE NONRELATIVISTIC HYDROGEN ATOM. Decoster, A. (Centre d'Etudes, Limeil, France). Nuovo Cim.; 68A: 105-17 (1 Jul 1970).

It is shown that the Fock's transformation can be split up into a change of variables with unitary transformation of operators and some special correspondence between a system — the H atom — and another — the 4-dimensional rotator — with conservation of the matrix elements, but nonunitary transformation of operators, i.e., modification of the physical contents of operators. This leads to rules of transformation of operators and especially a new form to be given to the Laplace–Runge–Lenz vector in order to make it Hermitian. A realization of the $SO_{2(4,1)}$ spectrum

group, directly as well as through the Fock's transformation, is also given, which puts the bound and free states on the same footing. (auth)

37265 ASYMPTOTIC RELATIONS BETWEEN THE THOMAS–FERMI–DIRAC AND THOMAS–FERMI ATOM MODELS. II. EXTENSION OF THE CASE OF LOW ATOMIC NUMBER. Hartle, R. E. (Goddard Space Flight Center, Greenbelt, Md.); Gilvarry, J. J. J. Chem. Phys.; 52: 5510-11(1 Jun 1970).

The asymptotic relation between the pressure with exchange in the Thomas–Fermi–Dirac atom model and the corresponding pressure without exchange in the Thomas–Fermi model for the case of low atomic number considered in the first paper of this series is generalized by including a correction corresponding to the first-order Coulomb contribution to the energy of the atom, in addition to the kinetic energy of the electrons alone. Comparison is made with numerical results obtained by direct solution of the Thomas–Fermi–Dirac equation. (auth)

37266 COMMENTS ON THE ANALYSIS OF ATOMIC CORRELATION ENERGIES. Gruninger, John; Oehrn, Yngve; Loewdin, Per-Olov (Univ. of Florida, Gainesville). J. Chem. Phys.; 52: 5551-4(1 Jun 1970).

Analysis of correlation energies is advocated in terms of average values of electronic kinetic energy, electron–nuclear attraction energy, and electron–electron repulsion energy, rather than pair energies. Exploratory calculations on the two-electron and three-electron isoelectronic sequences are reported. (auth)

37267 INDUCTION FORCES: AN EXACT TREATMENT OF CHARGE OVERLAP EFFECTS THROUGH THIRD ORDER. Singh, T. R.; Kreek, H.; Meath, William J. (Univ. of Western Ontario, London). J. Chem. Phys.; 52: 5565-71(1 Jun 1970).

The interaction of a ground-state atom or ion, consisting of a nucleus and a single electron, with a charge is considered in detail as a model for discussing induction forces through third order in the interaction potential. Expressions for all the angular components of the first-order wave function and for all the individual nonexpanded second-order induction energies are given in closed form. Exact numerical values for the total third-order induction energy and its individual nonexpanded components, through terms varying as R^{-11} at long range, are given in tabular form for the $H-H^+$ interaction. The results are discussed with emphasis on the effects of charge overlap on induction forces through third order and on the complicated structure of the third-order energy in terms of its individual nonexpanded induction energies. In the Appendix the Green function approach to the problem is discussed with the relevant Green functions being obtained as solutions of differential equations rather than by direct summation of their spectral expansions. (auth)

37268 ANALYTIC APPROACH TO ELECTRON CORRELATION IN ATOMS. White, Ronald J.; Stillinger, Frank H, Jr. (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Chem. Phys.; 52: 5800-14(1 Jun 1970).

A novel perturbative treatment of electron correlation in N-electron atoms is devised. The unperturbed starting point is a central-force "hydrogenic" problem in the full dN-dimensional configuration space (d = dimensionality). The central potential in this solvable "hydrogenic" problem is obtained by averaging the actual electron–electron and electron–nucleus potentials over all dN – 1 hyperspherical polar angles in the configuration space. The relevant projected Green's functions are computed for the ground states of the model one-dimensional two-electron atom (with delta function interactions), as well as for the real three-dimensional helium isoelectronic sequence. The corresponding first-order wave functions exhibit weakly singular logarithmic behavior (at three-particle confluence) of the type advocated by Fock. Second-order energies are evaluated for both of these two-electron problems. The basic ingredients of our hyperspherical coordinate method for three-electron atoms are displayed, in preparation for later application. Explicit suggestions are made for inclusion of singular terms in high-accuracy atomic and molecular variational wave functions. (auth)

37269 GENERAL THEORY OF AUTOIONIZING STATES OF TWO-ELECTRON SYSTEMS. Nazaroff, George V. (Michigan State Univ., East Lansing). J. Chem. Phys.; 52: 5873-83(1 Jun 1970).

The present theory is concerned with the bound-state components of autoionizing states. The bound and quasibound states of a two-electron system of a given symmetry type were grouped into clusters, and a wave function's natural eigenvalues (NEV's) were defined. The theory was used to show that the nth NEV of every approximate wave function can be made to yield an upper bound to the energy of any state in the nth cluster. The arguments for a two-electron system are extendable to an arbitrary many-electron system. Configuration-interaction (CI) results for several autoionizing states of an S-function helium atom were presented, and upper bounds to several autoionizing-state energies were obtained. The rather complicated structure of autoionizing-state CI roots was shown to result from the intersection of rather simple curves for the autoionizing states with CI roots belonging to states of lower clusters. The intersections are nonphysical and occur because an incomplete set of basis functions was used in the CI calculation. (auth)

37270 SPIN–ORBIT COUPLING CONSTANTS FROM GAUSSIAN WAVE FUNCTIONS. Hinkley, R. K.; Walker, T. E. H.; Richards, W. G. (Oxford Univ.). J. Chem. Phys.; 52: 5975-6 (1 Jun 1970).

In order to determine the suitability of Gaussian wave functions for calculation of spin–orbit coupling constants, calculations were made for the B, C, N, O, and F atoms using the wave functions of Huzinaga, which have a basis of 9 s-type and 5 p-type Gaussian atomic orbitals. The results are compared with calculations of others using Slater-type wave functions. Only slight differences were found; presumably the differences can be explained by a consideration of the charge distribution around the nucleus. It is concluded that Gaussian wave functions should be successful in calculations on small molecules. (A.G.W.)

37271 NEW PARTITIONING PERTURBATION THEORY. III. APPLICATIONS TO ELECTRON EXCHANGE. Certain, Phillip R.; Hirschfelder, Joseph O. (Univ. of Wisconsin, Madison). J. Chem. Phys.; 52: 5992-9(15 Jun 1970).

A new partitioning perturbation technique provides a rigorous derivation and generalization of the Hirschfelder–Silbey formalism for treating electron exchange problems. A new method of solving the first-order perturbation equation is introduced. The first-order wave function is the sum of the polarization function that describes van der Waals correlations and an exchange function that introduces ionic terms. The exchange function is determined variationally for both the ground-state $H + H^+$ and $H + H$ interactions. In the many-electron case, the first-order equation reduces to a set of one- and two-electron equations. (auth)

37272 NEW PARTITIONING PERTURBATION THEORY. II. EXAMPLE OF ALMOST DEGENERACY. Certain, Phillip R.; Dion, David R.; Hirschfelder, Joseph O. (Univ. of Wisconsin, Madison). J. Chem. Phys.; 52: 5987-92(15 Jun 1970).

A system of two coupled simple harmonic oscillators where many of the energy levels are almost degenerate doublets serves as an excellent "guinea pig" for testing many perturbation techniques including the modified Kirtman, Kirtman, and DE–FOP–VIM treatments discussed by Certain and Hirschfelder in a companion paper. These methods are compared with the "usual" approach to almost-degenerate problems, which makes the zeroth-order energies of the doublet pair degenerate by a suitable choice of the zeroth-order Hamiltonian. In addition, four types of Rayleigh–Schrödinger expansions are considered. The best values of the energy are given by the Kirtman treatment. However, the DE–FOP–VIM and the modified Kirtman procedures give values almost as good, and have the added advantage that they give upper bounds to the energy of the states considered. (auth)

37273 NEW PARTITIONING PERTURBATION THEORY. I. GENERAL FORMALISM. Certain, Phillip R.; Hirschfelder, Joseph O. (Univ. of Wisconsin, Madison). J. Chem. Phys.; 52: 5977-87(15 Jun 1970).

By the use of partitioning techniques, a general formalism is developed for considering degenerate, almost-degenerate, and electron-exchange perturbation problems. In effect, the Van Vleck–Kirtman approach to arbitrary orders and arbitrary normalization is generalized and three types of approximations are obtained: In the modified Kirtman treatment the functions through the Nth order are fully normalized and the energies are obtained as the roots of the secular equation. The DE–FOP–VIM approximation is the same except that the normalization of the functions is energy optimized. The Kirtman approximation uses the same functions as the modified Kirtman but the energies are obtained as the roots of a much simpler secular equation, which results from a factorization of the original secular equation (except for terms of order 2N + 2). The Kirtman energies are not upper bounds. Löwdin's formalism is equivalent to the modified Kirtman with the exception that Löwdin uses intermediate normalization. Electron-exchange problems are considered more explicitly in a companion paper with the use of symmetry considerations. (auth)

37274 INHOMOGENEITY CORRECTION TO EXCHANGE POTENTIAL. Darewych, J. W. (York Univ., Toronto). Phys. Rev., A; 2: 545-6(Aug 1970).

It is pointed out that the inhomogeneity correction term to the Gaspar–Kohn–Sham exchange potential proposed recently by Herman, Van Dyke, and Ortenburger (Phys. Rev. Lett., 22: 807

(1969)) follows, to within a numerical factor, from a similar correction to the statistical energy derived previously by Hohenberg and Kohn. The numerical coefficient in the latter case, obtained from Hubbard's work on electronic polarizabilities, is about four times larger than the average variational value of Herman, Van Dyke, and Ortenburger. (auth)

37275 SOME RESTRICTIONS ON THE USE OF REDUCED DENSITY MATRICES IN ATOMIC CALCULATIONS. Kijewski, L. J. (Monmouth Coll., West Long Branch, N. J.); Percus, J. K.; Pratt, I. H.; Tranchina, J. P. Phys. Rev., A; 2: 310-15(Aug 1970).

The method of reduced density matrices for obtaining the ground-state energy of an atomic system is developed, making full use of the symmetry relations for orbital and spin angular momentum. These, together with an extensive set of Hamiltonian-dependent identities, serve to decrease the number of parameters that must be varied in the density-matrix variational principle. With only a small number of parameters required, inequalities such as the Pauli restriction can then be enforced. Numerical calculations for C^{++} show the relative ineffectiveness of certain low-lying geminals (in the $\Gamma^{(2)}$ expansion) in reaching the Pauli restriction limit, and thus point the way to significant improvement. (auth)

37276 RADIATIVE DECAY OF COUPLED ATOMIC STATES. Fontana, Peter R.; Lynch, Donald J. (Oregon State Univ., Corvallis). Phys. Rev., A; 2: 347-52(Aug 1970).

The radiative decay of an atom with two excited states coupled by an external perturbation is investigated. The differential equations of motion are Fourier transformed and the probability amplitudes are obtained by contour integration. The real parts of the poles in the complex plane are the perturbed energies of the excited states, and the imaginary parts yield the decay characteristics. The decay probabilities of the excited states contain three different decay terms; two exponential decays and one modulated exponential decay. The probabilities of the final states give the frequency distribution of the emitted photons as a function of time. In an Appendix, the Heitler–Ma formalism is used to eliminate the final states of the system, and the resulting equations which contain damping terms are compared with the phenomenological method. (auth)

37277 NUMERICAL SOLUTION OF THE TWO-ELECTRON SCHROEDINGER EQUATION. Winter, Nicholas W.; Laferriere, Arthur; McKoy, Vincent (California Inst. of Tech., Pasadena). Phys. Rev., A; 2: 49-60(Jul 1970).

Numerical solutions to the S-limit equations for the helium ground state, excited triplet state, and the hydride-ion ground state are obtained with the second and fourth difference approximations. The results for the ground states are superior to previously reported values. The coupled equations resulting from the partial-wave expansion of the exact helium atom wave function are solved giving accurate S, P, D, F, and G limits. The G limit is −2.90351 a.u., compared to the exact value of the energy of −2.90372 a.u. (auth)

37278 HELLMANN–FEYNMAN THEOREM IN THOMAS–FERMI AND RELATED THEORIES. Goodisman, Jerry (Syracuse Univ., N. Y.). Phys. Rev., A; 2: 1-2(Jul 1970).

The general Hellman–Feynman theorem (derivative of energy with respect to a parameter = expectation value of derivative of Hamiltonian) is proved for theories in which the electron density is determined by making the energy functional stationary. Some simple applications are given. (auth)

Cosmic Radiation

Refer also to abstracts 36618, 36760, 37059, 37142, 37321, 37613, 37685, and 37807.

37279 (AD-701248) STUDY OF THE LOW-ENERGY SOLAR AND CELESTIAL GAMMA RADIATION. Final Report, March 18–September 17, 1969. Helmken, Henry F. (Smithsonian Astrophysical Observatory, Cambridge, Mass.). Oct 1969. Contract F19628-68-C-0297. 8p. (AFCRL-69-545). CFSTI.

Theoretical and design studies were conducted on gamma-radiation detectors for the energy range from 0.5 to 15 MeV. A NaI crystal detector and a gas Cherenkov detector were selected and used to obtain the gamma-ray growth curve from sea level to 125,000 ft. (auth) (USGRDR)

37280 (AD-703347) STUDY OF COSMIC RADIATION NEAR THE EARTH'S NORTH GEOMAGNETIC POLE. Final Report, April 15, 1965–January 31, 1970. Pomerantz, Martin A. (Bartol Research Foundation, Swarthmore, Pa.). 5 Mar 1970. Contract AF19(628)-5200. 54p. CFSTI.

Includes reprints.

Data were continuously recorded by the high-counting-rate neutron and meson detectors at Geopole Station, Thule, and were distributed to the World Data Centers. New equipment for providing punched paper-tape output, and for monitoring neutron multiplicities, was constructed. Many facets of a wide variety of cosmic-ray intensity variations were studied, including the solar diurnal variations, north–south asymmetries, and solar-particle precipitation. (auth) (USGRDR)

37281 (HASL-228) CALCULATION OF DOSE AND DOSE-EQUIVALENT RATES TO MAN IN THE ATMOSPHERE FROM GALACTIC COSMIC-RAYS. O'Brien, Keran; McLaughlin, James E. (New York Operations Office (AEC), N. Y. Health and Safety Lab.). May 1970. 22p. Dep. CFSTI.

An accelerator shielding code LUIN was adapted to the calculation of galactic cosmic-ray ionization, dose rates, and dose-equivalent rates as functions of altitude. Comparisons with spectral measurements were made and agreement is generally good. The sea-level ionization density and the derived dose-equivalent rates also agreed acceptably well with comparable measurements. Agreement among estimates of neutron dose rates was only fair, probably because of inadequately defined detector responses and dose models. The calculations permitted a parametric study of variations due to latitude and altitude, and such a study is now underway. (auth)

37282 (N-70-15208) NUCLEAR EMULSION RECORDINGS OF HEAVY PRIMARIES ON APOLLO 7 AND 8. Schaefer, Hermann J.; Sullivan, Jeremiah J. (Naval Aerospace Medical Inst., Pensacola, Fla.). Oct 1969. 15p. (NASA-CR-107565; NAMI-1091). CFSTI.

Data from Apollo 7 and 8, the former a 10.8-day orbital mission and the latter a 6.1-day lunar mission, are used for identifying the indicated difference of fluxes and energy spectra of galactic heavy primaries encountered on a lunar mission from those on a near-Earth orbital mission by measurements in the nuclear emulsions carried by the astronauts in their garments. A total of 84 track segments of $Z \geq 20$ was counted in 5.99 cm^2 emulsion area for Apollo 7 and of 76 segments in 1.82 cm^2 for Apollo 8. This represents a flux of 1.3 nuclei/cm^2 day for Apollo 7 and of 6.86/cm^2 day for Apollo 8. By applying OF factors as recommended by the ICRP to the absorbed doses of 0.42 millirad for Apollo 7 and 1.5 millirads for Apollo 8, the corresponding dose equivalents of 6.5 and 23.9 millirems, respectively, were obtained. These contributions constitute 4% of the total mission dose equivalent for Apollo 7 and 12% for Apollo 8. The results indicate that heavy nuclei contribute sizeably to the astronaut's radiation exposure on deep-space missions outside the magnetosphere. (auth) (STAR)

37283 (N-70-18641) LOW FREQUENCY COSMIC NOISE OBSERVATIONS OF THE CONSTITUTION OF THE LOCAL SYSTEM. Alexander, J. K.; Brown, L. W.; Clark, T. A.; Stone, R. G. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Jan 1970. 20p. (NASA-TM-X-63817; X-615-70-22). CFSTI.

Based on measurements of the low-frequency continuum radiation of the Galaxy, estimates were obtained for the gross distribution of thermal electrons, the synchrotron radiation emissivity, and the flux and spectrum of low-energy cosmic-ray electrons for the interstellar medium in the local system. The volume emissivity of the synchrotron radiation at 1 MHz is 10^{-39} W/(m^3 Hz sr). This value exceeds the emissivity deduced from measurements at higher frequencies over longer path lengths and in turn implies a low magnetic field between spiral arms ≤1 microgauss. For a mean interstellar magnetic field of 3 microgauss near the Sun, the radio data indicate a cosmic-ray electron intensity at 0.3 GeV of 1000 el/(m^2 sec sr GeV). That this intensity exceeds the value obtained from direct measurements by a factor of approximately 100 suggests either a large residual solar modulation or gradients in the interstellar distribution of cosmic rays. (auth) (STAR)

37284 ATMOSPHERIC PROPAGATION OF COSMIC RAY AND THE MODELS FOR MULTIPLE PRODUCTION. 2. EXTENSIVE SIMULATION. Kasahara, Katsuaki; Fujimoto, Yoichi; Hasegawa, Shun-ichi; Ohsawa, Akinori; Shibata, Toru (Waseda Univ., Tokyo). Uchusen Kenkyu; 14: 165-216(Oct 1969). (In Japanese).

Monte Carlo simulation was carried out for the propagation of cosmic rays in the atmosphere. The two-fireball model and the H-quantum hypothesis were adopted for the models of multiple production. The calculated energy spectrum of secondary particles turned out to be different for the two models used. This difference manifested itself also in γ/Pb ratio, in the lateral distribution of γ-ray family, and in $I_{\gamma}^{2nd}/I_{\gamma}^{ax}$. These quantities are indifferent to the uncertainty in the flux and the energy spectrum of primary particles. Comparison was made between the

result of simulation and the experimental data obtained by the Japan–Brazil group at Chacaltaya. Remarkable disagreement was found in the case of simulation made with the two fire-ball model. For the simulation with the H-quantum hypothesis, the agreement with the experiment was good for each quantity. Besides this, some important knowledge was obtained in this simulation, which may be useful in the emulsion chamber experiment. (NSA of Japan)

37285 RELATIVE ABUNDANCE OF THE CARBON ISOTOPES ^{12}C AND ^{13}C IN PRIMARY COSMIC RADIATION. Joensson, G.; Kristiansson, K.; Malmqvist, L. (Univ., Lund, Sweden). Astrophys. Space Sci.; 7: 231-51(May 1970).

Mass measurements were performed on stopping cosmic-ray carbon nuclei in a nuclear emulsion stack exposed to the primary radiation in a high-altitude balloon flight. The mass determinations were based on measurements of mean track width and residual range in the range intervals $0 < R < 0.75$ mm and $1 < R < 12$ mm. The mean track width measurements were performed with nuclear track photometers of special construction. The mass measurements in the interval $0 < R < 0.75$ mm gave a nearly symmetric mass distribution. The width of the distribution is equal to that expected for a distribution which contains only one isotope. The result indicates that one of the stable isotopes is appreciably more abundant than the other. The measurements in the range interval $1 < R < 12$ mm gave the isotopic ratio $^{13}C/(^{12}C + ^{13}C) = 0.08$. The ratio was extrapolated to the cosmic-ray source. It was found to be smaller in the source than at the point of measurement. Different assumptions about the origin of the cosmic radiation are discussed with regard to the results obtained in this investigation. (auth)

37286 ORIGIN OF COSMIC RAYS. II. THE HALO PROBLEM. GALACTIC MODELS. Ginzburg, V. L. Comments Astrophys. Space Phys.; 11: 43-52(Mar-Apr 1970).

In order to consider the galactic models of the origin of cosmic rays one must first of all chose the cosmic-ray trapping region, i.e., positively decide between the model with halo and the disk-type model discussed in Part I. Such a choice is linked to the answer to the question: does or does not the Galaxy have a pronounced halo? The problem of the halo is discussed in some detail. (W.D.M.)

37287 INTERSTELLAR ABSORPTION OF COSMIC X RAYS. Brown, Robert L. (National Radio Astronomy Observatory, Green Bank, W. Va.); Gould, Robert J. Phys. Rev., D; 1: 2252-6(15 Apr 1970).

Improved results on the total photo-ionization cross section of atomic helium are given. The total cross section includes contributions from simultaneous ionization and excitation of He^+ and double ionization; the combined effect of these two processes adds about 10% to the normal photo-ionization process where He^+ is left in the ground state. A lower abundance (10.92 based on 12.00 for hydrogen) is adopted for helium, based on recent radio determinations. In calculating the opacity due to K-shell photo-ionization of heavy elements, a lower abundance (8.00) is also adopted for neon. Brief mention is made of the effects of irregularities in the density distribution of the interstellar gas on the problems of both x-ray and radio-wave absorption. (auth)

37288 COSMIC-RAY MUON INTENSITY DEEP UNDERGROUND VERSUS DEPTH. Meyer, B. S. (Univ. of Witwatersrand, Johannesburg); Sellschop, J. P. F.; Crouch, M. F.; Kropp, W. R.; Sobel, H. W.; Gurr, H. S.; Lathrop, J.; Reines, F. Phys. Rev., D; 1: 2229-44(15 Apr 1970).

Cosmic-ray muons produced in the earth's atmosphere were measured at a depth of 8.71×10^5 g cm^{-2} with a large-area (170 m^2) liquid-scintillation-detector hodoscope. These data taken together with those of other workers lead to an improved muon vertical-depth intensity curve, $I_v(h) = a_\mu e^{-h/\lambda}$, where $I_v(h)$ = vertical intensity, $a_\mu = (1.04^{+0.21}_{-0.19}) \times 10^{-6}$ cm^{-2} sec^{-1} sr^{-1}, $\lambda = (8.04^{+0.55}_{-0.55}) \times 10^4$ g cm^{-2}, and h = depth in g cm^{-2}. A comparison of these results with those expected from the sea-level muon spectra via an improved calculation may indicate the need for an increased energy loss, probably via the photonuclear interaction as suggested by Keuffel et al. The results are not inconsistent with the presence of the X process of Keuffel et al. (auth)

37289 GEOMAGNETIC BENDING AND EFFECTIVE ANGLES OF APPROACH OF THE COSMIC RAYS FOR VARIOUS STATIONS. Chaloupka, P. (Inst. of Experimental Physics, Kosice, Czech.); Dubinsky, J.; Fischer, S.; Kowalski, T. Czech. J. Phys.; 20: 447-52(1970).

Data from 20 neutron monitor stations are used to estimate an effective geomagnetic bending for cosmic rays causing the diurnal variation of the neutron component at these stations. Correlation functions between each pair of stations were computed for that purpose and the temporal shifts giving the peak correlation were found. (auth)

37290 THE ELEVEN-YEAR AND RESIDUAL SOLAR MODULATION OF COSMIC RAYS (1952–1969). Simpson, J. A.; Wang, J. R. (Univ. of Chicago). Astrophys. J.; 161: 265-88(Jul 1970).

Experimental studies of the modulation of relativistic cosmic-ray nuclei in the Galaxy have been carried out over the period 1952-1969, which includes the two solar minima of modulation in 1954 and 1965. The observations are based on continuous measurements of intensity changes in the secondary nucleonic component at the geomagnetic rigidity cutoffs at 1.7, 3, and 13 GV, and therefore concern the changing primary spectrum of cosmic rays in the magnetic-rigidity range above ~2 GV. A series of fast-neutron balloon flights between the solar minimum of 1954 and the solar maximum of 1958 from Stagg Field, Chicago, is reported for the first time. This series provides an alternative experimental test of the results obtained by using continuous-recording neutron monitors. Aircraft flights carrying neutron monitors of geomagnetic rigidity cutoffs between 1 and ~5 GV provided independent comparisons of the flux levels of cosmic rays at the two solar minima. (W.D.M.)

37291 COSMIC-RAY-PRODUCED ^{24}Na AND OTHER NUCLIDES IN THE LOWER ATMOSPHERE. Roedel, Walter (Univ., Heidelberg). J. Geophys. Res.; 75: 3033-8(20 May 1970).

The concentration of cosmic-ray-produced ^{24}Na (15 hours half-life) in the lower atmosphere was calculated and measured, and the production rate of this nuclide as a function of altitude was estimated. The distribution of the specific activity was calculated for different sets of vertical eddy diffusion parameters. The concentration of ^{24}Na in the lower layers of the troposphere is sensitive to vertical eddy diffusion coefficients in the range of about 5×10^4 to about 3×10^6 cm^2 sec^{-1}, and at altitudes above 4 or 5 km the sensitivity of the ^{24}Na concentration to eddy-diffusion strength decreases. Several measurements of ^{24}Na, ^{22}Na, and ^7Be in ground-level air were carried out at Heidelberg during 1968. The measured ^{24}Na activities vary from 0.7×10^{-4} dpm/m^3 (low atmospheric turbulence) to 2.8×10^{-4} dpm/m^3 (high turbulence). The agreement between calculated values and measured specific activities is good. Some measurements of ^{24}Na in rain-water samples are also discussed. Both calculations and measurements suggest that short-lived cosmic-ray-produced nuclides are useful as tracers for atmospheric motions for a wide range of eddy diffusion parameters in the lowest 4 or 5 km of the troposphere. (auth)

37292 GALACTIC COSMIC-RAY ORIGIN OF Li, Be, AND B IN STARS. Reeves, H. (Institut d'Astrophysique, Paris. Service d'Electronique Physique, Saclay, France); Fowler, W. A.; Hoyle, F. Nature (London); 226: 727-9(23 May 1970).

A study is described of the implications of the hypothesis that high-energy processes involving cosmic rays acting on the interstellar medium are the sources of the elements, Li, Be, and B present in stellar atmospheres and in the solar system. (auth) (UK)

Direct Energy Conversion

37293 (AD-703314) PERFORMANCE OF A LARGE SCALE NONEQUILIBRIUM MHD GENERATOR WITH RARE GASES. Zauderer, B. (General Electric Co., Philadelphia, Pa. Space Div.). Feb 1970. Contract Nonr-3867(00). 68p. (TR-14). CFSTI.

Supersedes PB-120141.

An experimental study was performed of the operating characteristics of a large linear, supersonic MHD generator. A shock tunnel was used to heat the test gases, primarily a 99% neon + 1% xenon mixture, to stagnation pressures of 1 to 5 atm, temperatures of about 3500°K, and electron densities on the order of 10^{10}/cc. The test time of 5 milliseconds, about 10 times the traversal time of the gas through the generator, was sufficient to produce quasi-steady-state conditions in the channel. It was concluded that electrode conduction losses and shock-wave formations were the two major factors limiting the efficiency of this generator. (auth) (USGRDR)

37294 (JUL-CONF-3) SURFACE PHENOMENA OF THERMIONIC EMITTERS. Round Table Conference held in Juelich, Germany, June 10, 1969. (Kernforschungsanlage, Juelich (West Germany)). Nov 1969. 63p. (CONF-690637).

This conference emphasized the surface properties of thermionic emitters which must be studied in order to yield high-efficiency and long-lifetime converters. The ten papers, one of which is only an abstract, cover cesium adsorption on W, work function measurements, surface states from band structures, effects of interstitial O and C on Zr work function, high-work function dispenser cathodes, fabrication of cermet electrodes, electron emission by Mo–Sr surfaces, stability of heat-treated W and Mo surfaces, and effects of adsorbed electronegative gases on work function. (D.L.C.)

37295 EXPERIENCES AND EXPERIMENTAL RESULTS WITH THE CLOSED-LOOP ARGAS I. Bohn, T.; Komarek, P. (Kernforschungsanlage, Juelich, Ger.). Energy Convers.; 10: 75-9(Apr 1970).

Conversion of heat directly to useful electrical energy by means of thermoelectric techniques has moved during the past few years from the laboratory to fully developed production hardware. A brief description is given of presently available commercial TEGs, the thermoelectric materials used and heat sources. The basis of the design of the TEGs is described in light of requirements for commercially acceptable units. A brief analysis is made of the economics of TEGs relative to other competitive power sources, such as batteries and small MG sets to show how TEGs is considered to be of prime importance and demonstrated by presenting a series of applications in actual use and relevant operational and performance characteristics. (auth) (UK)

Fluid Physics

Refer also to abstract 37111.

37296 SYSTEM OF CURRENT LINES IN MAGNETOHYDRODYNAMICS. Bray, Marcel. Compt. Rend., Ser. A, 269: 109-12 (July 16, 1969). (In French).

Several properties of the lines of current studied by the J. Ehlers technique are presented. (tr-auth)

37297 LINEARIZED PISTON PROBLEM IN RADIATION MAGNETOGASDYNAMICS. Nye, V. A. (Univ. of Strathclyde, Glasgow). Quart. J. Mech. Appl. Math.; 23: 247-64(May 1970).

A study was made of the effects of thermal radiation on the propagation of small disturbances caused by a plane radiating piston whose temperature is raised slightly and which moves slowly from rest into an infinitely electrically conducting radiating gas in the presence of an applied transverse magnetic field. It was found that for small times the main disturbance travels at the magneto-acoustic speed. For some intermediate time the main disturbance travels at the magnetoisothermal speed, and ultimately it travels at the magnetoacoustic speed. The damping and diffusion of these waves is also discussed. (auth) (UK)

Geophysics (Upper Atmosphere)

Refer also to abstracts 36436 and 37125.

37298 (AD-684400) SOLAR WIND. VOLUME I. Report Bibliography, 1953-August 1968. (Defense Documentation Center, Alexandria, Va.). Feb 1969. 160p. (DDC-TAS-68-79). CFSTI.

The annotated bibliography contains 123 solar wind references from the DDC collection that have been cataloged since 1953. Topical arrangement by subject includes general studies of the solar wind, satellite, and spacecraft applications, and physical effects of the solar wind. (auth) (USGRDR)

37299 (AD-698585) OBSERVATION OF GEOSTATIONARY SYNCOM III. Report No. 2 (Annual), March 1968-March 1969. Pai Kwang-Hong (National Taiwan Univ., Taipei. Dept. of Electrical Engineering). Jul 1969. 15p. (ARDG(FE)-401-2). CFSTI.

Total electron content and scintillation observations made at Taipei by receiving radio signal from Syncom III are examined. There exists post-sunset peak in electron content which has the greatest occurrence and largest peak value in March. The ratio of the electron contents for sunspot numbers 110 and 14 at this latitude is estimated to be about 3.4. The plasma temperature derived from the equivalent slab thickness of scale height for April varies from 850°K at 00 to 02 hour to 1400°K at 13:30 hour, and its daytime maximum lags 1.5 hours behind that of the solar radiation. The diurnal patterns of the scintillation occurrence for March, April, and May differ considerably. It is possible that the difference can be attributed to the ionospheric irregularities situated at different heights. (auth) (USGRDR)

37300 (AD-699568) SOLAR PARTICLE OBSERVATIONS OVER THE POLAR CAPS. Report for January 1968-June 1969. Paulikas, George A.; Blake, J. Bernard; Vampola, Alfred L. (Aerospace Corp., El Segundo, Calif.). 18 Nov 1969. Contract F04701-69-C-0066. 21p. (TR-66(5260-20)-8; SAMSO-TR-69-415). CFSTI.

Solar particle observations made aboard USAF-OAR low-altitude polar satellites are summarized. It is found that solar electrons can reach the polar caps; the boundary of trapped electrons determines the cutoff for low-energy solar protons near the midnight meridian; and scattering of low-energy solar protons must occur in order to account for the experimental observations. (auth) (USGRDR)

37301 (AD-701937) LOW FREQUENCY FLUCTUATIONS IN THE EARTH'S MAGNETIC FIELD. Final Report, September 1, 1964-August 31, 1967. Sees, J. Edwin; Noland, J. Hubert (South Carolina Univ., Columbia. Dept. of Electrical Engineering). 31 Aug 1967. 7p. (AROD-5207:1-P). CFSTI.

The project was directed toward the design of an experiment and the development of instrumentation and measuring techniques useful for observing micropulsations in the magnetic field strength and in the related telluric currents. The program required auxiliary tests and measurements to validate the test environment. (auth) (USGRDR)

37302 (AD-702145) SOLAR-GEOPHYSICAL FORECAST AIDS AND DECODE PROGRAMS. Final Report, December 1967-November 1969. Reed, Lawrence; Enger, Isadore (Travelers Research Corp., Hartford, Conn.). Dec 1969. Contract F19628-68-C-0096. 26p. (AFCRL-70-4). CFSTI.

The development of objective aids for predicting flare occurrence and geomagnetic activity and the development of a set of computer programs to decode solar-geophysical codes are described. The contribution made by magnetic classification and magnetic intensity of sunspots as precursor variables for predicting flare occurrence is investigated. The usefulness of trend analysis is investigated for predicting the geomagnetic planetary index. (auth) (USGRDR)

37303 (AD-702762) AN INVESTIGATION OF THE EFFECTS OF SOLAR FLARES AND STRATOSPHERIC WARMINGS ON THE LOWER IONOSPHERE. Rowe, J. N. (Pennsylvania State Univ., University Park. Ionosphere Research Lab.). 15 Jan 1970. Contract Nonr-656(35). 90p. CFSTI.

A number of studies are made of D-region electron density profiles measured by the wave-interaction technique. Changes in electron density observed during a solar flare on October 21, 1968 are analyzed to determine an upper limit to the nitric oxide concentration. This limit is about 30,000,000/cm^3 at 80 km. The result is then applied to the normal diurnal variation of electron density, and it is shown that the diurnal variation is consistent with value of NO. Some electron density measurements during a stratosphere warming are also presented. (auth) (USGRDR)

37304 (AD-702854) PARTICLE BOMBARDMENT OF THE POLAR ATMOSPHERE. Final Report, October 1, 1966-December 31, 1969. Brown, Robert R.; Weir, Robert A.; Hones, E. W. Jr.; Parthasarathy, R.; Karas, Richard H. (California Univ., Berkeley. Cosmic Ray Group). Jan 1970. 9p. (AFOSR-70-141-TR). CFSTI.

Research was directed at studying the bombardment of the polar atmosphere by radiations accompanying solar and magnetic disturbances. The program was based on using radiation detectors on balloon-borne platforms and measuring the fluxes, spectra, time variations, and geophysical associations of the incoming radiation. The radiation encountered at high latitudes consisted of protons, accelerated at the sun and propagated through interplanetary space to the earth, and electrons, accelerated within the magnetosphere of the earth and guided to high latitudes by the geomagnetic field. (auth) (USGRDR)

37305 (AD-703694) MECHANISM FOR THE ORIGIN OF THE VAN ALLEN BELT. Progress Report. Pizzella, G. (Iowa Univ., Iowa City. Dept. of Physics and Astronomy). Mar 1970. Contract N00014-68-A-0196-0003. 14p. CFSTI.

A model of the Van Allen belt is proposed in which the resonance acceleration of the exospheric plasma particles by stochastic electromagnetic waves plays an important role. The differential energy spectrum for trapped protons is derived in the energy range ≈200 keV to a few MeV for L shells between about 2 and 6 R_E. (auth) (USGRDR)

37306 (AD-703709) VLF EMISSIONS AND ELECTRON INSTABILITIES. Report for June 1968-June 1969. Cornwall, John M. (Aerospace Corp., El Segundo, Calif.). 1 Dec 1969. Contract F04701-69-C-0066. 22p. (TR-66(5260-20)-12; SAMSO-TR-70-108). CFSTI.

Current research into vlf emissions and the electron instabilities that cause them are reviewed. Data were gathered by OGO 1, 3, and 5 that have led to the identification of a type of narrow bandwidth chorus, now called banded chorus. Purely electrostatic modes were also seen and studied in detail, especially on OGO 5. Observation of triggered emissions and the nonlinear theories invoked to explain the emissions are included. (auth) (USGRDR)

37307 (AD-703710) THE AEROSPACE CORPORATION SPACE SCIENCE PROGRAM REPORT TO COSPAR, CY 1969. Paulikas, George A. (Aerospace Corp., El Segundo, Calif.). 31 Dec 1969.

Contract F04701-69-C-0066. 24p. (TR-66(5260-01)-1; SAMSO-TR-70-111). CFSTI.

Results obtained during 1969 by the space research programs of The Aerospace Corporation are presented. The results deal primarily with studies of the upper atmosphere radiation belt physics, and the interaction of solar cosmic rays with the magnetosphere. (auth) (USGRDR)

37308 (AD-704178) ON THE ORIGIN OF THE VAN ALLEN PROTONS. Progress Report. Pizzella, G.; Knorr, G.; Randall, B. A. (Iowa Univ., Iowa City. Dept. of Physics and Astronomy). Mar 1970. Contract N00014-68-A-0196-0003. 29p. CFSTI.

The experimental data on protons trapped in the Van Allen belt obtained with the Injun 5 satellite are compared with a model recently proposed. The experimental data show a minimum in the energy spectrum that is predicted by the theory under the assumption that the wave energy be proportional to the plasma density. Furthermore, the experimental data for $2 < L < 6$ and for energies from 300 keV to 2 MeV can be described, as predicted, by a universal energy spectrum. The model also describes the experimental result of other authors that $E_0 \simeq L^{-3}$ at the equator, E_0 being the e-folding energy. (auth) (USGRDR)

37309 (N-68-25872) A PROGRAM OF GROUND-BASED STUDIES OF THE ZODIACAL LIGHT. Weinberg, J. L. (Haleakala Observatory (Hawaii)). 1967. 15p. (NASA-CR-87730). CFSTI.

Nonzodiacal light sources of appreciable polarization in the nightglow are discussed, with particular mention made of the polarization associated with the 6300- and 5577-Å airglow line emissions. The origin of this polarization is discussed, and a figure is included to show that the diurnal variation of the plane of polarization at 5080 Å is primarily associated with the zodiacal light and the changing position of the sun with respect to the observer and the celestial pole. The polarization at 5577 Å is not solar-oriented, and preliminary calculations suggest that such polarization may be explained by tropospheric scattering of an unpolarized radiation incident on the scattering atmosphere from the E and/or F regions. Methods of separating the zodiacal light from starlight and airglow are assessed. An empirical technique for deriving the starlight is illustrated by plotting the observed brightness at 5300 Å for part of an almucantar including the peak zodiacal light and regions of both high and low galactic latitude. It is pointed out that airglow line emission can be avoided by careful selection of the filters. Observations of Comet 1965f and the zodiacal cloud, and lunar liberation clouds are mentioned. (STAR)

37310 (N-69-32508) TWENTY-FOUR HOUR CHANGES IN THE ELECTRIC CONDUCTIVITY OF THE LAYER OF THE DAILY IONOSPHERE. Mishin, V. M.; (and others). Translated from Izv. Akad. Nauk SSSR, Sib. Otd., Sib. Inst. Zemnogo Magn. Ionos. Rasprostr. Rad.; No. 1, 78-83(1966). 10p. (NASA-CR-103531). CFSTI.

An evaluation is given of integral (along the altitude) values of the tensor components of ionospheric electrical conductivity for points on the midday meridian in the regions of geographic colatitudes $10° > \theta > 170°$. Formulas determining integral conductivities of Pedersen, Hall, and the actual conductivities were used. Results show that universal time changes in electrical conductivity in the daily ionosphere are an important factor which determines the regular 24 hour changes of ionospheric currents which originate in the dynamo region. (auth) (STAR)

37311 (N-69-32510) THE EFFECT OF DAILY (24 HOUR) PRECESSION OF THE GEOMAGNETIC DIPOLE ON THE CREATION OF SQ-VARIATIONS. Akopian, A. V. Translated from Izv. Akad. Nauk SSSR, Sib. Otd., Sib. Inst. Zemnogo Magn. Ionos. Rasprostr. Rad.; No. 1, 84-9(1966). 10p. (NASA-CR-103533). CFSTI.

The dynamo theory of Sq variations is developed, taking into account the noncoincidence of magnetic and geographic axes of the Earth. A generalized Ohm's law is used to calculate dynamo region currents. (auth)

37312 (N-69-32552) SEASONAL VARIATIONS OF MEDIUM-LATITUDE SQ-CURRENTS ACCORDING TO MGG DATA (IGY). Mishin, V. M.; (and others). Translated from Izv. Akad. Nauk SSSR, Sib. Otd., Sib. Inst. Zemnogo Magn. Ionos. Rasprostr. Rad.; No. 1, 90-101(1966). 18p. (NASA-CR-103526). CFSTI.

A typical system of ionospheric currents responsible for Sq variations is presented. Basic parameters are the values of intensity of the northern and southern current vortices, the coordinates of the foci, and the distribution of current density in the coordinates ϕ, t. The seasonal changes of these parameters are analyzed, based on data for each of the months of the year. Together with the mean daily systems of the Sq currents, the seasonal changes in the parameters of the instantaneous current systems are briefly investigated. Average Sq fields were studied, based on data from stations in the American longitudes. IGY observations within the latitude limits of $|\phi| < 60°$ were used. (auth) (STAR)

37313 (N-69-32617) FIELD OF SUDDEN STARTS' MAIN IMPULSES NEAR THE LOCAL ABSORPTION REGION OF COSMIC RADIO-NOISE IN THE IONOSPHERE. Ivanov, K. G. Translated from Izv. Akad. Nauk SSSR, Sib. Otd., Sib. Inst. Zemnogo Magn. Ionos. Rasprostr. Rad., No. 1, 102-9(1966). 14p. (NASA-CR-103532). CFSTI.

Sudden starts of magnetic storms not preceded by an absorption either in the polar region or in the lights region are investigated. Magnetograms of 12 sudden starts observed during the IGY in Canada, Alaska, and Scandinavia were studied, and their absorption data are given. The distributions of horizontal components of the main impulse field in the northern and southern hemispheres are tabulated, and the field distributions are mapped for the sudden starts of 21 July, 31 August, and 22 October, 1958. Similarities, characteristics, and possible origins are discussed. (STAR)

37314 (N-69-32715) INSTANTANEOUS ASPECTS OF SQ-CURRENTS ACCORDING TO DATA ON THE EQUINOX SEASON DURING THE IGY. Mishin, V. M.; (and others). Translated from Izv. Akad. Nauk SSSR, Sib. Otd., Sib. Inst. Zemnogo Magn. Ionos. Rasprostr. Rad.; No. 1, 49-61(1966). 23p. (NASA-CR-103527). CFSTI.

A continuation of the investigation of Sq-field dynamics is presented, based on IGY world network data, processed by fast computers. The main aims are to work out a method of computation of instantaneous current systems responsible for Sq variations, and learn about the regular changes in the Sq field as affected by the universal time of day. (auth) (STAR)

37315 (N-70-16999) SEASONAL VARIATIONS IN THE F2 REGION. Mayr, H. G.; Mahajan, K. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Jun 1969. 33p. (NASA-TM-X-63793; X-621-69-255). CFSTI.

Semiannual and annual variations in the F2 region are discussed based on critical frequency and radar backscatter observations during the descending phase of solar activity (1958 to 1965). The semiannual effect appears as a persistent feature of the ionosphere that is not related to fluctuations in the 10.7-cm noise or the euv radiation. This gives support to theories that attribute the semiannual effect to variations in the lower atmosphere. The annual variation in the ionosphere, showing a winter to summer enhancement in the F2 peak density at low latitudes and during low solar activity, can be explained by meridional winds at ionospheric heights. These winds also have a significant effect on the height of the F2 peak and appear to be effective throughout the solar cycle as evident from radar backscatter observations that show the peak at higher altitudes in summer than winter. (auth) (STAR)

37316 (N-70-17319) A SURVEY OF LOW-ENERGY (E GREATER THAN 5 keV) ELECTRON ENERGY FLUXES OVER THE NORTHERN AURORAL REGIONS WITH SATELLITE INJUN 4. Craven, J. D. (Iowa Univ., Iowa City. Dept. of Physics and Astronomy). Jul 1969. Contract Nonr-1509(06). 65p. (NASA-CR-107842). CFSTI.

Observations of the energy fluxes of ≥5-keV electrons at low altitudes (approximately 525 to 2500 km) over the northern auroral regions were made by the nearly polar orbiting Injun 4 satellite from February 1965 through July 1966 during a period of minimum solar activity. Results of the first detailed survey of the percentages of occurrence of the energy fluxes of ≥5-keV electrons in the outer radiation/auroral zone, as a function of magnetic local time and invariant latitude, are graphically displayed for various energy flux thresholds. The greatest occurrences of these energy fluxes were observed in the night–dawn morning hours of local time, at latitudes from approximately 65 to 70°. The spatial distributions of these contours are compared with those for the occurrences of optical auroras. Limited simultaneous observations of these energy fluxes at pitch angles of ~40° and ~90° showed that the ratios of these energy fluxes are typically >0.1, with a condition of isotropy occurring for energy fluxes ≥1 erg/cm^2 sec sr^{-1}. (auth) (STAR)

37317 (N-70-17394) OGO 4 OBSERVATIONS OF ION COMPOSITION AND TEMPERATURES IN THE TOPSIDE IONOSPHERE. Chandra, S.; Troy, B. E. Jr.; Donley, J. L.; Bourdeau, R. E. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Jan 1970. 36p. (NASA-TM-X-63805; X-615-70-1). CFSTI.

Direct measurement of the densities of various ionic constituents and the temperatures of ions and electrons were obtained from the OGO 4 planar retarding-potential analyzer in the altitude range 400 to 900 km. Results are presented from day and night passes in the

mid and low latitudes near the 1967 fall equinox. The passes are selected to emphasize the latitudinal rather than the height dependence of the measurements. (auth) (STAR)

37318 (N-70-17417) ELECTRIC FIELD OBSERVATIONS OF IONOSPHERIC WHISTLERS. Maynard, N. C.; Aggson, T. L.; Heppner, J. P. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Dec 1969. 34p. (NASA-TM-X-63808; X-645-70-11). CFSTI.

A Nike-Tomahawk sounding rocket was launched near local noon on November 8, 1966 from Wallops Island with a triaxial electric field experiment using long cylindrical dipoles for sensors. Twenty elf whistlers with dispersion constants ranging from .15$^{\frac{1}{2}}$ to .85$^{\frac{1}{2}}$ sec were detected and identified as having propagated up to the rocket through the E region from the earth-ionosphere waveguide. The data extend to the smallest dispersion ever encountered and the lowest frequencies observed on ionospheric whistlers (60 Hz). The waves were eliptically polarized, becoming more nearly circular at higher altitudes. Analysis showed good agreement between the experimental results and quasi-longitudinal propagation theory for amplitude, dispersion, and polarization characteristics of the wave once one is away from the D to E region boundary. No appreciable effects of negative ions or protons were observed in the dispersion of the whistlers. (auth) (STAR)

37319 (N-70-17448) A SURVEY OF THE TOTAL RADIATION IN SPACE OBSERVED BY THE OGO SATELLITES, SEPTEMBER 5, 1964-May 27, 1968. Kane, S. R.; Winckler, J. R. (Minnesota Univ., Minneapolis. School of Physics and Astronomy). Sep 1969. Contract NAS5-2071. 210p. (NASA-CR-107886; CR-135). CFSTI.

Graphical and tabular summaries of the ionization rates in space recorded by the large spherical ion chambers on the OGO-1 and OGO-III spacecraft are presented. The survey begins with the launch of OGO-I in September 1964 and ends with the last reduced data furnished on a regular basis by the Data Reduction Facility at Goddard Space Flight Center in May 1968 although some samples of data are given in July and August 1968 from special runs. The ionization chambers are sensitive to all types of particle and photon radiation which can penetrate the aluminum shell. The hourly average rates of the ion chambers were computed without regard to the location of the satellite and as a function of universal time for the entire period. Background radiation is measured outside the magnetosphere during periods of solar quiet. On each pass of the satellite the radiation belts are shown as large spikes with the radiation zones in general unresolved with the one hour averages and with the peak rates consistent with an average over this time period. (auth) (STAR)

37320 (N-70-17624) DESCRIPTION OF DATA PLOTS FROM THE UNIVERSITY OF MINNESOTA ION CHAMBER AND ELECTRON SPECTROMETER ON OGO-1 AND OGO-3. Kane, S. R.; Pfitzer, K. A.; Winckler, J. R. (Minnesota Univ., Minneapolis. Cosmic Ray Group). Oct 1969. Contract NAS5-2071. 40p. (NASA-CR-107885; CR-147). CFSTI.

Samples of computer plots and their explanations are presented for electron spectrometer and ionization chamber data on radiation belts, solar radiation, and galactic cosmic rays. The electron spectrometer data are plotted against such factors as time, range, and L values. All of the spectrometer data are plotted in the same arbitrary scale which must be multiplied by the conversion factor to obtain the electron fluxes or the differential energy spectra. The data for the five energy channels are background-corrected and plotted against a normalized scale. A list of completed data plots is presented. (STAR)

37321 (N-70-17654) OPERATION OF A THREE-FREQUENCY RIOMETER SYSTEM ON THE NASA 711 AIRCRAFT DURING THE 1968 AURORAL EXPEDITION. Bradbury, J. N. (Lockheed Missiles and Space Co., Palo Alto, Calif.). 15 Jan 1969. Contract NASw-1682. 32p. (NASA-CR-107853; LMSC-N-83-69-1). CFSTI.

Auroral absorption events observed during the 1968 auroral expedition are discussed. The multifrequency riometer system is described, and data acquisition procedures and noise problems encountered are discussed. Absorption events are correlated with visual and photometric observations of the auroral conditions. (STAR)

37322 (N-70-18559) ROCKET INVESTIGATION OF THE AURORAL GREEN LINE. Parkinson, T. D.; Zipt, E. C.; Donahue, T. M. (Pittsburgh Univ., Pa. Space Research Coordination Center). 15 Oct 1969. Contract NASr-179. 26p. (NASA-CR-108092; SRCC-107). CFSTI.

Results obtained from rocket-borne photometers, electron energy analyzers, and ion mass spectrometers show that direct excitation of atomic oxygen by auroral electrons can excite only a small fraction of the auroral green line observed. From measured ion distributions, dissociative recombination of O_2^+ is shown to contribute only weakly to the excitation of O(1S) except at high altitudes. It is proposed here that dissociative excitation of O_2 can account for the major portion of the production of O(1S) if the cross section for the process is of the order 10^{-16} cm^2. Dissociative recombination supplements this mechanism at high altitude and produces about 10% of the total emission. (auth) (STAR)

37323 (N-70-18861) MODEL STUDY OF PLASMAPAUSE MOTION. Grebowsky, J. M. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Dec 1969. 19p. (NASA-TM-X-63813; X-621-69-543). CFSTI.

A simple time-dependent model that accounts for the observed behavior of the bulge is developed for the plasmapause motion during periods of changing magnetic activity. The development of a steady-state model is described, based on the assumption that the geomagnetic field arises from a magnetic dipole centered in the Earth with no tilt between the dipole and the axis of rotation, and the effects of currents external to the Earth are ignored. In the equatorial plane of this model the gross electric field that drives the plasma flow is derived from two sources: (1) the rotation of the conducting Earth through the dipole magnetic field producing a polarization charge within the Earth that produces an electric field directed radially outwards; (2) the interaction between the solar wind and the magnetosphere is another component, and corresponds to a plasma flow toward the Sun from the magnetosphere tail. Based on this model, a time-dependent model is developed. (STAR)

37324 (N-70-19274) MAGNETIC FIELD FLUCTUATIONS IN THE EARTH'S MAGNETOSHEATH. Fairfield, Donald H.; Ness, Norman F. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Jan 1970. 27p. (NASA-TM-X-63825; X-692-70-20). CFSTI.

IMP 4 measurements were used to study magnetic field fluctuations in the sunward hemisphere of the magnetosheath. Power spectra were computed in the frequency range below 0.2 Hz in a field-aligned coordinate system that allows the separation of transverse and longitudinal perturbations. Power levels on different passes through the magnetosheath typically vary by an order of magnitude or more and spectral peaks are frequently seen throughout the frequency range studied. Spatial variations of wave amplitudes are characterized by enhancements of the transverse mode near both the shock and the magnetopause but these variations tend to be smaller than the day to day variations. On three unique orbits when the bow shock was located more than 9 R_E outside its average location the magnetosheath power levels were depressed by more than an order of magnitude below their normal lowest levels. Transverse fluctuations were dominant at these times. A weak positive correlation was found between magnetosheath fluctuations and geomagnetic activity. (auth) (STAR)

37325 CHEMISTRY OF THE IONOSPHERE. Danilov, A. D. Monographs in Geoscience. New York; Plenum Press (1970). 309p. $22.50.

Translation of Khimiya Ionosfery.

The chemical and photochemical processes of the earth's ionosphere at altitudes greater than 60 km are reviewed. A model of ionization-recombination processes is presented, and ion-molecular reactions and dissociative recombination are discussed. An examination of the chemical kinetics of the lower ionosphere is made with emphasis on reactions involving negative ions. The problems associated with nitrogen and oxygen dissociation and the chemistry of nitrogen oxides and hydrogen compounds in the upper atmosphere are analyzed. A brief consideration of the ionospheres of the giant planets is made. New data published in the world literature on the problems dealt with in the book are noted in an appendix. (J.C.W.)

37326 MEASUREMENT OF IONOSPHERE BY THE GYROPLASMA PROBE. Ejiri, Masaki; Obayashi, Tatsuzo (Tokyo Univ.). Rep. Ionosphere Space Res. Jap.: 24: 1-12(Mar 1970).

The Kappa 8-15 sounding rocket was launched in January 1969, at Kagoshima Space Center of the University of Tokyo. The gyroplasma probe was installed to study the various kinds of plasma resonance phenomena closely related with fundamental parameters of ionospheric plasma. The probe system was designed to measure the probe admittance in a vector form, namely with amplitude and phase, over the frequency range of 0.7 to 17 MHz at intervals of 0.3 sec. The electron density was obtained with an accuracy of ±1% from the upper hybrid resonance frequency, and the electron temperature was deduced from the probe admittance. Electron density and electron temperature profiles in the altitude range of 90 to 200 km showed pronounced spatial irregularities in the evening ionosphere. The effect of the electrostatic cyclotron resonance upon the probe admittance was observed. (auth)

37327 ROCKET OBSERVATION OF VLF RADIO WAVES IN THE IONOSPHERE. Hayakawa, Masashi; Ohtsu, Jinsuke; Iwai, Akira (Nagoya Univ., Japan). Rep. Ionosphere Space Res. Jap.; 24: 13-23(Mar 1970).

The record of vlf wide-band receiver on board the K-9M-26 rocket is discussed. A large number of short fractional-hop whistlers originating around the launching site were observed, and from the altitude variation of their dispersion the electron density profile of the ionosphere with layer structure was derived. Also the analysis of ordinary whistlers showed that once whistlers have emerged above the maximum density region of the ionosphere, they echo back and forth between the northern and southern hemispheres by nonducted propagation, resulting in large dispersion. (auth)

37328 FINE STRUCTURE OF ULF EMISSIONS IN THE FREQUENCY RANGE OF 0.1 ~ 2 Hz. Kokubun, Susumu (Tokyo Univ.). Rep. Ionosphere Space Res. Jap.; 24: 24-44(Mar 1970).

Fine-structured ulf emissions in the frequency above 0.1 Hz were investigated using data obtained at Syowa Station, Antarctica, in 1966 and 67. It is shown that the ulf emissions can be classified into four types, hydromagnetic whistler, periodic hydromagnetic emission, hydromagnetic chorus, and sweeper. This classification is made referring to the vlf emission spectra, because the ulf emissions show characteristics similar to vlf emissions in many respects. For periodic HM emission, three subtypes may be defined, nondispersive, dispersive, and drifting, as in the case of vlf emissions. The characteristics of HM chorus with a spectrum composed of irregularly spaced risers and dots, which usually occur in the daytime at high latitudes, are also similar to those of vlf polar chorus. These correspondences indicate that essentially similar mechanisms would be operative in vlf and ulf emission generation. (auth)

37329 PROGRESSIVE CHANGE IN $\pi 2$ POWER SPECTRA WITH THE DEVELOPMENT OF MAGNETOSPHERIC SUBSTORM. Fukunishi, Hiroshi; Hirasawa, Takeo (Tokyo Univ.). Rep. Ionosphere Space Res. Jap.; 24: 45-65(Mar 1970).

The waveforms and power spectra of $\pi 2$ observed in the auroral zone are different from those of $\pi 2$ observed simultaneously at mid and low latitudes at the onset of a magnetospheric substorm. A predominant period can be found in irregular wave trains of mid- and low-latitude $\pi 2$, while waveforms of auroral-zone $\pi 2$ are irregular and power spectra are of a random noise type as $f^{-\alpha}$. For pc 4 and $\pi 2$ observed at low latitudes, their features such as waveforms, dependence of periods on Kp, and local time are common. The decrease in $\pi 2$ period with increasing Kp index is interpreted by an inward motion of the plasmapause in the magnetosphere. When several $\pi 2$ wave trains occur intermittently during a magnetospheric substorm, the waveforms and power spectra of each wave train are found to be very similar to one another. The fundamental periods of $\pi 2$ wave trains are also found to decrease gradually with the development of magnetospheric substorm, and this is in agreement with Carpenter and Stone's observational result (1967) on the motion of the stable plasmapause toward the smaller L shells in the course of magnetospheric substorm. Low-latitude $\pi 2$ are considered to be the transient surface waves on the plasmapause excited by HM disturbances. A good correlation was found between the auroral-zone $\pi 2$ and the fluctuations in auroral luminosity. The predominant spectral peaks of auroral-zone $\pi 2$ of 1 to 10-sec period become more notable in the course of a polar magnetic substorm, and then $\pi 2$ is transformed gradually to narrow-band irregular ($\pi 1$) pulsations. The auroral-zone $\pi 2$ are considered to result from the fluctuations of ionospheric current produced by the time-dependent precipitation of energetic particles into the upper atmosphere, and the modulation of precipitation seems to be favorably produced with the progress of magnetospheric substorm. (auth)

37330 LONG-PERIOD GEOMAGNETIC PULSATIONS (pc 5) WITH TYPICAL SINUSOIDAL WAVEFORMS. Hirasawa, Takeo (Tokyo Univ.). Rep. Ionosphere Space Res. Jap.; 24: 66-79 (Mar 1970).

Geomagnetic pulsations pc 5 most frequently observed in the polar region were investigated in detail by means of IGY data, especially with respect to the dependence of pc 5 appearance on geomagnetic activity, latitudinal and local-time variation in pc 5 period and amplitude, and the pulsation waveforms at different latitudes. Important characteristics of pc 5 obtained through the analysis are: (1) the region of pc 5 occurrence shifts equatorward with increase in the geomagnetic activity; (2) there is a systematic diurnal variation in average pc 5 period, shortest in the morning hours and becoming gradually longer towards the evening; (3) on the high-latitude side of the region of pc 5 occurrence, multipulsive geomagnetic fluctuation is often observed; this will indicate that pc 5 pulsations can be excited not only by the isolated SC (or SI) but also by continuous pulse-like disturbing forces originating from the magnetosphere. Judging from these morphological evidences, it may be postulated that hydromagnetic waves caused by some instability in the plasma sheet are propagated through the magnetosphere, and give rise effectively to a standing oscillation of line of magnetic force at the trapping boundary, which would be observed as pc 5 on the Earth's surface. (auth)

37331 SOURCE OF HIGH-ENERGY PROTONS IN THE VAN ALLEN RADIATION BELT. Farley, T. A. (Univ. of California, Los Angeles); Tomassian, A. D.; Walt, Martin. Phys. Rev. Lett.; 25: 47-9(6 Jul 1970).

A reasonable fit to the observed high-energy proton distribution in the inner zone of the Van Allen radiation belt is obtained when the mechanism of radial diffusion is added to a cosmic-ray-produced albedo-neutron-decay source and an atmospheric collision loss mechanism. The radial diffusion mechanism transports protons inward from the outer zone to make up the serious deficiency of the albedo-neutron source at low magnetic moments, and at the same time redistributes protons of high magnetic moment in a way that is consistent with experimental observations. (auth)

37332 PARTICLE INFLUX AND THE WINTER ANOMALY IN THE MIDLATITUDE (L = 2.5 to 3.5) LOWER IONOSPHERE. Manson, A. H.; Merry, M. W. J. (Univ. of Saskatchewan, Can.). J. Atmos. Terrest. Phys.; 32: 1169-81(Jul 1970).

The two explanations for the "winter anomaly" of radio wave absorption: (1) changes in the neutral and ionized components of the atmosphere because of meteorological influences and (2) enhancements in, or the introduction of, an ionizing corpuscular flux of precipitated particles, are briefly reviewed. There is now convincing evidence that the first explanation is involved in the anomaly. The second explanation is investigated using mid-latitude (L = 2.5 to 3.5) particle precipitation data and electron density measurements below 100 km. It is first shown that the effect of the "anomaly" is a maximum above 80 km, where ionization due to particle influx is a maximum. Ionization rates and electron densities due to various measured fluxes of precipitated electrons are then calculated, assuming an isotropic angular distribution. Effective recombination rates of 10^{-5} and $\approx 5 \times 10^{-7}$ cm^3/sec near 80 km are used. An average flux (N(>40 keV) = 5×10^3 electrons/cm^2 sec ster) of electrons, and a few high flux "events" could contribute 3 and 9 db respectively to the monthly mean noon absorption at 2.4 MHz. This compares with the total "anomaly" of ≈15 db. The effect of seasonal changes in the parameters of the neutral atmosphere is shown to be significant in the calculation of ionization below 100 km. Mean noon electron density profiles due to photoionization and particle ionization for summer and winter atmospheres are similar to measured profiles. Both sets of profiles reveal that electron densities between 80 and 88 km are comparable in winter and summer. It is concluded that two explanations for the winter "anomaly", presented in order of importance, are: changes in the neutral and ionized components of the atmosphere because of meteorological influences, and a seasonally constant flux of precipitated electrons. The two processes are linked through the neutral density and pressure changes. (auth) (UK)

37333 UNDERSIDE MORPHOLOGY OF THE F2 IONOSPHERIC LAYER. Knudsen, W. C.; Sharp, G. W.; Harris, K. K. (Lockheed Palo Alto Research Lab., Calif.). J. Atmos. Terrest. Phys.; 32: 1183-90(Jul 1970).

Underside morphology of the night F2 layer was derived for a magnetically quiet period at sunspot minimum. Total ionic concentration from which the morphology was derived was measured in situ on a low-altitude satellite that decayed substantially in altitude during the three days of data acquisition. The general picture of the morphology is as follows: the layer is lowered near the geographic equator in the form of an inverted ridge and is elevated on either side of the ridge at approximately ±25° latitude. This general picture is distorted for a range of longitudes centered on 270°E. At this location the layer is anomalously high in the southern hemisphere and anomalously low in the northern hemisphere. The general picture of the morphology is explained as resulting from downward plasma drift near the equator induced by a westward electric field and vertical plasma drift at midlatitude induced by equatorward directed neutral winds. The distorted behavior at 270°E longitude may result from low latitude conjugate transfer of ionization at that longitude. (auth) (UK)

37334 EVALUATION OF ELECTRON DENSITY FROM VLF DOPPLER MEASUREMENTS IN A ROCKET. Egeland, A.; Bjoentegard, G. (Norwegian Inst. of Cosmic Physics, Oslo). J. Atmos. Terrest. Phys.; 32: 1191-204(Jul 1970).

A narrow band vlf receiver was flown in a Tomahawk rocket during quiet daytime conditions from Wallops Island. The highly frequency stabilized transmitter NSS (21.4 kHz), located about

300 km from the range, was received. NSS transmitted continuous waves during the flight period. Ten meter long cylindrical whips, with a 1-in. dia., mounted perpendicular to the rocket body, were used as antennas. A short description of the vlf receiver and the analyzing technique is given. The recorded frequency in the rocket showed a significant Doppler shift. The local electron density was calculated at each point along the rocket trajectory from these Doppler measurements. The results are compared with data obtained by different techniques, and the feasibility of using the vlf Doppler technique for electron density measurements in the lower ionosphere is demonstrated. (auth) (UK)

37335 SOME TESTS OF METHODS OF ANALYSIS OF IONOSPHERIC DRIFT RECORDS USING AN ARRAY OF 89 AERIALS. Golley, M. G.; Rossiter, D. E. (Univ. of Adelaide). J. Atmos. Terrest. Phys.; 32: 1215-33(Jul 1970).

Results from an array of 89 aerials are used to test the validity of the usual methods of measuring ionospheric drifts, in which only three aerials are used. It is shown that the magnitude of the "true" velocity determined by "full correlation analysis" increases as the size of the aerial triangle increases, and tends to a limit which is the correct value. The "apparent" velocity, which is equal to the velocity obtained by the "method of similar fades", shows no variation with triangle size, but gives consistently high values. The "correlation ellipse" shows a tendency to be aligned along the hypotenuse when small right-angled triangles are used. An explanation of these results is given in terms of instrumental effects in the recording and digitizing process. It is suggested that there is an optimum aerial separation for spaced receiver experiments, and that this is considerably larger than has usually been employed in the past. For E-region measurements, an equilateral triangle of side about 300 m is recommended. (auth) (UK)

37336 A SEQUENCE OF ROCKET OBSERVATIONS OF NIGHTTIME SPORADIC E. Smith, L. G. (GCA Tech. Div., Bedford, Mass.). J. Atmos. Terrest. Phys.; 32: 1247-57 (Jul 1970).

The variation of the structure of the nighttime E region was observed in a series of five rocket flights from Wallops Island, Virginia, on February 22, 1968. The launch times were 0009, 0130, 0300, 0430, and 0602 EST. Electron density profiles were obtained by Langmuir probe during rocket ascent. A sporadic-E layer, identified as the intermediate or E2 layer of radio observations, is found in the upper E region. It is observed at 140 km in the first two profiles and subsequently descends until finally merging with the lower, irregular, region. The layer is initially blanketed by the underlying layers but later appears in ionograms as sequential sporadic E. Long persistence of layers in the lower E region is also noted. (auth) (UK)

37337 SOME PROPERTIES OF IONOSPHERIC IRREGULARITIES AS DEDUCED FROM RECORDINGS OF THE SAN MARCO II AND BE-B SATELLITES. Kelleher, R. F.; Sinclair, J. (University Coll., Nairobi, Kenya). J. Atmos. Terrest. Phys.; 32: 1259-71(Jul 1970).

Recordings of scintillations on signals received at Nairobi from satellites San Marco II and BE-B were analyzed by correlation and dispersion methods, the correlation method equations being derived in a simpler way. The dispersion technique, which gives more detailed results, was used to derive the height variation of irregularity size and occurrence. The peak of occurrence is found to be near h_mF2. The average size is somewhat greater than 100 m and does not vary significantly with height. On individual passes, the height of irregularities increases towards the magnetic equator. Irregularity patches are found to move with a velocity of about 20 $msec^{-1}$ towards the east before 0600 LMT and to the west after this time. There is evidence of some vertical structure. It is shown that there is considerable polarization scintillation at 20 MHz. (auth) (UK)

37338 SOLAR X-RAY CONTROL OF THE E LAYER OF THE IONOSPHERE. Sengupta, P. R. (Univ. of Iowa, Iowa City). J. Atmos. Terrest. Phys.; 32: 1273-82(Jul 1970).

Solar x-ray control of the E layer of the ionosphere was investigated. Electron production rates between 100 and 140 km above the Earth due to 31 to 100 Å solar x-ray flux extrapolated from x-ray data recorded by Explorer 30, OGO-4, and OSO-4, and due to reported xuv flux from rocket and satellite experiments were calculated to show that about 70% of the E-layer ionization is contributed by the x rays. Calculated E-layer electron densities due to solar x-ray flux on two typical days were compared with the E-layer electron density profile. The $f_0E/\cos\chi$ over Ottawa (45°N) and Washington, D. C. (39°N) during November 1966 to March 1967 were seen to be closely related with 44 to 60 Å x-ray flux measured by Explorer 30. Correlation with 8 to 20 Å flux was poorer. The $(f_0E)^4/\cos\chi$ over Manila (15°N) and Breisach (48°N) during the period July 1966 to June 1968 exhibited a linear relation with x-ray flux. The relation is given approximately by: $(f_0E)^4/\cos\chi = a + b \cdot F(31 \text{ to } 100 \text{ Å}) + c \cdot F(10 \text{ to } 30 \text{ Å})$. The first term represents ionization due to xuv and is related to the 11-yr sunspot cycle. The second and third terms represent x-ray contribution and show day-to-day variation depending on the daily solar activity level, in addition to the 11-yr variation with sunspot cycle. Effective recombination coefficients of the layer calculated from the term coefficients are in agreement with accepted values. It was concluded that 31 to 100 Å solar x rays, which contribute about 70% of the E-layer ionization on a day of moderate solar activity, are responsible for day-to-day variations in the E-layer index. Contribution of 10 to 30 Å solar flux to the E-layer ionization is small except on a day of high solar activity. (auth) (UK)

37339 GRADIENT INSTABILITY IN BOUNDED IONOSPHERIC LAYERS. Whitehead, J. D. (Univ. of Queensland, Brisbane). J. Atmos. Terrest. Phys.; 32: 1283-304(Jul 1970).

Exact solutions for the growth rate of a perturbation in exponential layers have been given. These solutions suffer from the defect of becoming infinite in either the ionization perturbation or potential perturbation at infinity. It seems desirable, therefore, to solve the problem for a bounded layer. Such a bounded layer also more closely resembles an ionospheric region than does the exponential layer. The appropriate differential equations for a bounded layer are derived on the basis of a number of assumptions, the most important one being that the space charge distribution is very nearly aligned along the magnetic field (the ionization perturbation need not be, however). It is shown by numerical calculation that solutions to these differential equations do not represent growing perturbations, though the lifetime of the perturbations may be much longer than diffusion acting alone would allow. It is possible that bounded layers in space do not suffer from the gradient instability. (auth) (UK)

37340 WINTER ANOMALY AND RELATED TRANSPORT PHENOMENA. Zimmerman, S. P.; Narcisi, R. S. (Air Force Cambridge Research Labs., Bedford, Mass.). J. Atmos. Terrest. Phys.; 32: 1305-8(Jul 1970).

The Richardson criterion (R_i), which is a measure of the presence or absence of turbulence, was calculated from measurements taken during and after a "winter anomaly." The results indicate that during the anomaly, the atmosphere is fairly stable ($R_i > 1$) from 60 km up to about 78 km but between 78 and 90 km, in the same altitude range where the electron density is seen to be most enhanced, the atmosphere is turbulent as defined by the condition $R_i < 1$. This contrasts with the normal day, where the condition for the existence of turbulence extends over the entire altitude range from 68 to 86 km. (auth) (UK)

37341 DAILY VARIATION OF F-REGION DRIFTS AT THUMBA. Chandra, H.; Rastogi, R. G. (Physical Research Lab., Ahmedabad, India). J. Atmos. Terrest. Phys.; 32: 1309-11 (Jul 1970).

The measurements of F-region electron drifts at Thumba during the year 1967 indicate the direction to be westward during the daytime and eastward during nighttime, the reversals occurring between 0600–0700 hr and 1900–2000 hr. A significant increase of drift speed occurs about an hour before the morning as well as the evening reversal. The results are in excellent agreement with the electron drifts measured by Doppler shift of vhf scatter echoes at Jicamarca. (auth) (UK)

37342 PARTIAL REFLECTIONS OF GRAVITY WAVES OBSERVED BY MEANS OF A METEORIC RADAR. Revah, I. (Centre National d'Etudes des Telecommunications, Issy-les-Moulineaux, France). J. Atmos. Terrest. Phys.; 32: 1313-17 (Jul 1970).

Observations of the zonal component of the wind in the lower ionosphere show the existence of gravity waves with periods of a few hours. The vertical variations of their amplitude are interpreted in terms of partial reflections by temperature discontinuities. A least-mean-square method yields values of the reflection coefficient and of a parameter related to the scale height. (auth) (UK)

37343 ELECTRON DENSITY IN THE LOWER IONOSPHERE AND THE WINTER ANOMALY IN HF ABSORPTION. Beynon, W. J. G.; Williams, E. R. (University Coll. of Wales, Aberystwyth). J. Atmos. Terrest. Phys.; 32: 1325-9(Jul 1970).

The hf absorption observed on a "winter anomaly" day is compared with that calculated from a measured N(h) profile. On both normal and abnormal days a major part of the total absorption occurs within a short distance of the reflection point. Comparison of the N(h) profiles for normal and abnormal days indicates enhancement of the electron density in the lower ionosphere at all levels above 70 km but the major effect seems to occur in the 80 to 90 km height range. (auth) (UK)

37344 SOLSTITIAL S_q CURRENTS THROUGH THE MAGNETOSPHERE. Van Sabben, D. (Royal Netherlands Meteorological Inst., De Bilt). J. Atmos. Terrest. Phys.; 32: 1331-6(Jul 1970).

Starting from a theoretically derived expression for the density of the electric current which escapes upwards from the ionosphere, the S_q currents which flow along the magnetic lines of force through the magnetosphere as a consequence of the asymmetry in conductivity between the northern and southern hemispheres were computed for the month of June 1958. The result is a current of 30,000 A, passing through the magnetosphere from north to south in the morning sector and back in the afternoon sector. A current of this type will always be present during solstices, but it will be superposed by a current, caused by the asymmetry of the ionospheric winds, which is as yet of unknown type. From an order of magnitude calculation it is concluded that the latter current will generally dominate. (auth) (UK)

37345 INVESTIGATION OF CORRELATIONS BETWEEN IONOSPHERIC WINDS IN THE E REGION AND METEOROLOGICAL PHENOMENA IN THE LOWER ATMOSPHERE. Haubert, A. (GRI, Garchy, France). J. Atmos. Terrest. Phys.; 32: 1337-42(Jul 1970). (In French).

An attempt is made to relate the ionospheric winds in the E region, observed by the method of fadings, with the meteorology of lower regions. In spite of the considerable height difference between the two related phenomena (about 100 km for ionospheric winds and 5 km for the altitude of 500 mbar) the monthly curves indicate a relative delay of one to four days. These preliminary results, still not sufficiently adequate, tend to stimulate further investigations towards stratospheric–ionospheric relations. (auth) (UK)

37346 PLASMA WAVES IN SPACE AND IN THE LABORATORY. VOLUME 1. Proceedings of NATO Advanced Study Institute, Roeros, Norway, April 17–26, 1968. Thomas, J. O.; Landmark, B. J. (eds.). New York; American Elsevier Publishing Company, Inc. (1969). 494p. $23.50. (In English and French). (CONF-680455-(Vol.1)).

Separate abstracts were prepared for the 21 individual papers. (M.O.W.)

For abstracts of individual papers see: 37347–37359, 37441, 37443, 37444, and 37509–37513.

37347 RESONANCES OBSERVED BY RADIO PULSE SOUNDERS AND THEIR APPLICATION TO MEASUREMENTS IN SPACE. Thomas, J. O.; Andrews, M. K. (Imperial Coll. of Science and Tech., London). pp 3-39 of Plasma Waves in Space and in the Laboratory. Vol. I. /Thomas, J. O. (ed.). New York; American Elsevier Publishing Co., Inc. (1969).

From Conference on Plasma Waves in Space and in the Laboratory, Roeros, Norway. See CONF-680455-(Vol.1).

Observations of plasma oscillations and their identification are described. The theory of plasma waves is described with emphasis on the dependence of the group velocities on frequency The duration of the signals and the damping of the oscillations are also discussed. The ways in which the excitation of plasma resonance phenomena can be used for measurements and experiments in space plasmas are also discussed. (M.O.W.)

37348 RESONANCES IN THE IONOSPHERE. Calvert, W. (ESSA Labs., Boulder, Colo.). pp 41-54 of Plasma Waves in Space and in the Laboratory. Vol. I. /Thomas, J. O. (ed.). New York; American Elsevier Publishing Co., Inc. (1969).

From Conference on Plasma Waves in Space and in the Laboratory, Roeros, Norway. See CONF-680455-(Vol.1).

Observations of resonances in the ionosphere are reviewed. First, the satellite experiments are discussed; then the observations are presented. Brief comparisons are made between observations and theoretical predictions. (M.O.W.)

37349 RESONANCES OBSERVED BY THE ALOUETTE TOPSIDE SOUNDERS. Barrington, R. E.; Hartz, T. R. (Defence Research Telecommunications Establishment, Ottawa). pp 55-79 of Plasma Waves in Space and in the Laboratory. Vol. I. /Thomas, J. O. (ed.). New York; American Elsevier Publishing Co., Inc. (1969).

From Conference on Plasma Waves in Space and in the Laboratory, Roeros, Norway. See CONF-680455-(Vol.1).

Observations of ionospheric resonances obtained by the swept frequency sounders of Alouette I and II are described. One area given special attention is that of resonance effects that appear in the recordings of the automatic-gain-control voltage of the sounder receiver. (M.O.W.)

37350 RADIATION FROM A DIPOLE IN MAGNETIZED PLASMAS. Dougherty, J. P. (Univ. of Cambridge, Eng.). pp 83-95 of Plasma Waves in Space and in the Laboratory. Vol. I. /Thomas, J. O. (ed.). New York; American Elsevier Publishing Co., Inc. (1969).

From Conference on Plasma Waves in Space and in the Laboratory, Roeros, Norway. See CONF-680455-(Vol. 1).

The behavior of an antenna carried by a satellite in the ionosphere was studied. The theory begins with a study of plane waves in a uniform plasma, and finally, an analysis is given for a dipole immersed in a plasma. (M.O.W.)

37351 RF-PROBE ADMITTANCE IN THE IONOSPHERE: THEORY AND EXPERIMENT. Balmain, K. G.; Oksiutik, G. A. (Univ. of Toronto). pp 247-61 of Plasma Waves in Space and in the Laboratory. Vol. I. /Thomas, J. O. (ed.). New York; American Elsevier Publishing Co., Inc. (1969).

From Conference on Plasma Waves in Space and in the Laboratory, Roeros, Norway. See CONF-680455-(Vol.1).

The developments in theory and experiments for rf probe admittances are reviewed. These are for both isotropic and anisotropic plasma. Some data are discussed. (M.O.W.)

37352 IMPEDANCE OF A RADIO-FREQUENCY PLASMA PROBE IN A STATIC MAGNETIC FIELD. Holt, O. (Auroral Observatory, Tromso, Norway); Troeim, J. pp 263-84 of Plasma Waves in Space and in the Laboratory. Vol. I. /Thomas, J. O. (ed.). New York; American Elsevier Publishing Co., Inc. (1969).

From Conference on Plasma Waves in Space and in the Laboratory, Roeros, Norway. See CONF-680455-(Vol.1).

The inclusion of magnetic fields in the hot plasma theory is discussed. This is described for a probe consisting of two parallel plates. This theory and a simple cold plasma theory are compared. Then a similar cold plasma theory is applied to a spherical probe, using an effective dielectric constant obtained by simply averaging over all directions. Results from laboratory experiments are compared with this theory. (M.O.W.)

37353 QUADRIPOLE PROBE FOR STUDY OF IONOSPHERIC PLASMA RESONANCES. Storey, L. R. O.; Aubry, M. P.; Meyer, P. (CNRS-GRI, Saint-Maur-des-Fosses, France). pp 303-32 of Plasma Waves in Space and in the Laboratory. Vol. I. /Thomas, J. O. (ed.). New York; American Elsevier Publishing Co., Inc. (1969).

From Conference on Plasma Waves in Space and in the Laboratory, Roeros, Norway. See CONF-680455-(Vol.1).

The basics of using pairs of impedance probes for plasma diagnostics are outlined. The point-source transfer impedance function was derived for a cold plasma. The performance of asymmetric and symmetric probes in plasma was studied with and without magnetic fields. The usefulness of quadrupole probes in the study of ionospheric plasma resonances is discussed. (M.O.W.)

37354 VLF EMISSIONS. Helliwell, R. A. (Stanford Univ., Calif.). pp 335-60 of Plasma Waves in Space and in the Laboratory. Vol. I. /Thomas, J. O. (ed.). New York; American Elsevier Publishing Co., Inc. (1969).

From Conference on Plasma Waves in Space and in the Laboratory, Roeros, Norway. See CONF-680455-(Vol.1).

The properties of vlf emissions emanating from the magnetosphere are discussed. The discussion is first concerned with auroral hiss and discrete emissions with associated hiss. Next, the triggering of emissions is considered under the general heading of natural events and man-made events. Finally, the interpretation of emissions is reviewed with most attention being given to the longitudinal and transverse resonances between electrons and electromagnetic waves propagating in the whistler mode. (M.O.W.)

37355 SATELLITE OBSERVATIONS OF VLF RESONANCES. Barrington, R. E. (Defence Research Telecommunications Establishment, Ottawa). pp 361-78 of Plasma Waves in Space and in the Laboratory. Vol. I. /Thomas, J. O. (ed.). New York; American Elsevier Publishing Co., Inc. (1969).

From Conference on Plasma Waves in Space and in the Laboratory, Roeros, Norway. See CONF-680455-(Vol.1).

A number of vlf and elf phenomena that are related to various singularities of the ionospheric plasma are discussed. These include signals originating in lightning discharges and noise observations. (M.O.W.)

37356 OBSERVATIONS OF PLASMA WAVES IN SPACE. Scarf, F. L. (TRW Systems, Redondo Beach, Calif.); Crook, G. M.; Fredricks, R. W.; Green, I. M.; Kennel, C. F. pp 379-404 of Plasma Waves in Space and in the Laboratory. Vol. I. /Thomas, J. O. (ed.). New York; American Elsevier Publishing Co., Inc. (1969).

From Conference on Plasma Waves in Space and in the Laboratory, Roeros, Norway. See CONF-680455-(Vol.1).

The techniques used to measure plasma waves in space and some of the unique problems associated with this type of research are discussed. Low-altitude electric and magnetic field data, primarily obtained in a spacecraft experiment, are presented. Preliminary results from Pioneer 8 and OGO 5 are also presented. (M.O.W.)

37357 MOTION OF A CHARGED PARTICLE IN THE FIELD OF A WHISTLER-MODE WAVE PACKET. Dungey, J. W. (Imperial Coll. of Science and Tech., London). pp 407-15 of Plasma Waves in Space and in the Laboratory. Vol. I. /Thomas, J. O. (ed.). New York; American Elsevier Publishing Co., Inc. (1969).

From Conference on Plasma Waves in Space and in the Laboratory, Roeros, Norway. See CONF-680455-(Vol.1).

Particle trajectories are calculated in the linear approximation for plane waves in uniform fields, wave packets, and nonuniform steady fields. The phenomenon of trapping of resonant particles in a wave is also discussed. (M.O.W.)

37358 CYCLOTRON RESONANCE AMPLIFICATION OF WHISTLERS IN THE MAGNETOSPHERE. Liemohn, H. B. (Boeing Scientific Research Labs., Seattle). pp 437-49 of Plasma Waves in Space and in the Laboratory. Vol. I. /Thomas, J. O. (ed.). New York; American Elsevier Publishing Co., Inc. (1969).

From Conference on Plasma Waves in Space and in the Laboratory, Roeros, Norway. See CONF-680455-(Vol.1).

The interaction between individual electromagnetic wave packets and distributions of nonthermal charged particles that have anisotropic pitch-angle distributions was studied. An experimental application of the theory to vlf whistlers is demonstrated. (M.O.W.)

37359 ELECTROMAGNETIC PITCH-ANGLE INSTABILITIES IN SPACE. Kennel, C. F.; Scarf, F. L. pp 451-74 of Plasma Waves in Space and in the Laboratory. Vol. I. /Thomas, J. O. (ed.). New York; American Elsevier Publishing Co., Inc. (1969).

From Conference on Plasma Waves in Space and in the Laboratory, Roeros, Norway. See CONF-680455-(Vol.1).

A review is given of parallel propagating right- and left-hand electromagnetic waves and instabilities in a plasma with an arbitrary ratio of particle-to-magnetic pressure. The discussion is given as follows: (1) dispersion relations, (2) lf Alfven and ion cyclotron waves, (3) parallel whistlers, (4) oblique whistlers, and (5) hf instabilities. Solar wind and Van Allen belt anisotropic instabilities are described. (M.O.W.)

37360 OBSERVATION OF THE VAN ALLEN RADIATION ZONE WITH THE RADIO SOUNDING TECHNIQUE FROM THE EARTH'S SURFACE IN ANTARCTIC CONTINENT. Molski, Janusz. Artif. Satell.; 5: No. 1, 13-25(Oct 1969).

Results obtained from observations carried out in Antarctica during the polar expedition organized by the Geophysics Institute of the Polish Academy of Sciences in 1965/67 are reported. With the radio-sounding technique, the investigators succeeded in observing a high zone of charged particles, extending above the F layer, at a height of 840 to 1500 km, and in defining its electron density. Detailed analyses of the quiet and perturbed states of the magnetosphere seem to admit that it was the inner Van Allen zone. In addition, signals from a higher layer, roughly 3900 km, were received, but it was found later that they were reflections from the Earth, called the "backscatter." The radiation zone was successfully used for long-distance radio communication in the range of 14 to 16 MHz. (auth)

37361 ACOUSTIC COUPLING INTO THE IONOSPHERE FROM SEISMIC WAVES OF THE EARTHQUAKE AT KURILE ISLANDS ON AUGUST 11, 1969. Waver, P. F.; Yuen, P. C.; Proiss, G. W.; Furumoto, A. S. (Univ. of Hawaii, Honolulu). Nature (London); 226: 1239-41(27 Jun 1970).

A second example of the disturbance of the ionosphere by an earthquake was reported at the University of Hawaii after the August 11, 1969 Kurile Islands quake (estimated magnitude 7.8). Whilst propagating along the surface of the Earth the seismic waves launched acoustic waves that travelled almost vertically upwards into the atmosphere, and these pressure waves moved the contours of ionospheric constant electron density up and down with oscillatory motions similar to those of the acoustic pressure waves. This motion of the contours caused the reflection heights of WWVH signals to move up and down, producing Doppler shifts. Doppler records monitoring the motions of constant electron density contours should therefore have shapes similar to the seismic records, and such comparisons are shown graphically. One of the properties of the acoustic propagation path above 150 km is an attenuation which is larger for the higher frequency components, and in effect the atmosphere acts like a low-pass filter. As a result, only the low-frequency components reach the higher levels in the ionosphere. The experimental data provide further evidence that surface waves generated by earthquakes produce acoustic waves that travel to heights of at least 340 km. They also confirm the low-pass action of the atmosphere and some of the dispersive characteristics of seismic propagation. (UK)

37362 CHEMILUMINESCENT REACTIONS IN THE AIRGLOW. Young, Robert A. (York Univ., Toronto). Can. J. Chem.; 47: 1927-37(15 May 1969).

Laboratory experiments on chemiluminescent reactions involving atomic oxygen of pertinence to the nightglow are reviewed. From simple consideration it is shown that the atomic oxygen concentration in the upper atmosphere must be larger than the presently accepted value of 2×10^{11} atoms/cm^3 at the peak in the atomic oxygen altitude profile. Rocket measurements of the volume emission intensity of 5577 Å radiation and laboratory measurements of the rate of its excitation by three-body atomic oxygen association indicate a peak upper atmospheric atomic oxygen concentration near 10^{12} atoms/cm^3. The excitation of molecular oxygen emission in atomic association is a multistep process involving at least one quenchable precursor. Laboratory results are inadequate to define the excitation mechanism but a strongly temperature-dependent precursor deactivation process is required for laboratory observation to be consistent with the hypothesis that atomic association is the cause of nightglow O_2 emission. Other processes are briefly discussed. (auth)

37363 CORRELATION BETWEEN SOLAR WIND AND GEOMAGNETIC ACTIVITY. Pichler, Helmut (Univ., Vienna). Arch. Meteorol., Geophys. Bioklimatol., Ser. A; 19: 89-94(1970). (In German).

The correlation between the solar wind measurements of the satellites Vela 3 and 4 in the period from January 1, 1969, until May 31, 1969, and the geomagnetic activity was investigated and compared with the measurements of the Mariner 2 experiment in the period from August 29, 1962, until January 3, 1963. It is shown that on magnetically disturbed days the Mariner 2 satellite has measured a larger solar wind velocity than the satellites Vela 3 and 4 though in the period from September to December 1962 the solar activity was much less than in the period from January to May 1969. Further investigations will be necessary to explain this fact. (auth)

37364 VERTICAL STRUCTURE OF THE TROPOSPHERE AS REVEALED BY RADIOACTIVE TRACER STUDIES. Bhandari, N.; Lal, D.; Rama (Tata Inst. of Fundamental Research, Bombay). J. Geophys. Res.; 75: 2974-80(20 May 1970).

The fallout of several radioisotopes of diverse origins (i.e., cosmogenic isotopes ^{7}Be and ^{32}P, radiogenic ^{210}Pb, ^{210}Bi, and ^{214}Bi, and bomb-produced ^{22}Na) was measured in precipitation at several stations on the Indian subcontinent. The average residence time of cosmogenic (and bomb-produced) isotopes in the troposphere is found to be longer than that of the radiogenic isotopes. This behavior can be explained only if the rate of removal of aerosols, in general, decreases with altitude. Such a structure of the troposphere is probably seasonally variable. The concentrations of ^{210}Pb, ^{7}Be, and ^{32}P were measured in the air in the troposphere. The results, combined with similar data, suggest that the concentrations in the troposphere at 0 to 15°N latitude are unusually small. This effect seems to be a direct result of good vertical mixing and efficient washout in this belt. (auth)

37365 ESTIMATED ION MOBILITIES FOR SOME AIR CONSTITUENTS. Mason, E. A. (Brown Univ., Providence). Planet. Space Sci.; 18: 137-44(Feb 1970).

Estimates, based on available experimental data and on theory, are given for the mobilities of the ions O^+, N^+, O_2^+, and NO^+ in the neutral species He, O, N, O_2 and N_2 from 0 to 2500°K. (auth) (UK)

37366 CONCENTRATION WAVES IN THE IONOSPHERE. Fedorovich, G. V. Geomagn. Aeron. (USSR)(Engl. Transl.); 9: 679-82(1969).

Translated from Geomagn. Aeron.; 9: 842-6(1969).

The influence of a concentration disturbance of the absorbing agent on the state of the ionosphere below the disturbed layer is examined. (auth)

37367 OBSERVATIONS OF THE ZODIACAL LIGHT WITH A BALLOON-BORNE TELESCOPE. Vande Noord, Edwin L. (Univ of New Mexico, Albuquerque). Astrophys. J.; 161: 309-16(Jul 1970).

Observations of the zodiacal light at elongation angles between 25° and 50° from the Sun were obtained with sounding balloons during the solar minimum of 1964-1965. Results on the surface brightness, color index, and degree of polarization of the zodiacal light from four morning flights and three evening flights are presented. The observations suggest that a difference exists in the brightness distribution of the zodiacal light along the ecliptic between the evening and the morning; no significant difference, however, is detected in the polarization and in the average color index of the zodiacal light. (auth)

37368 APOLLO 4 AND 6 RADIATION ANALYSIS. White, Timothy T.; Hardy, Alva C. (Manned Spacecraft Center, Houston, Tex.). J. Spacecraft Rockets; 7: 785-8(Jul 1970).

A primary objective of the unmanned Apollo 4 and 6 missions was to obtain radiation measurements inside an Apollo command

module while passing through the most intense portions of the trapped radiation belts. Measurements of the integrated radiation dose behind shields of 0.015 and 0.9 in. of aluminum were made inside the command module on both missions. Dose-rate measurements behind similar shielding were obtained in the Apollo 6 command module during the ascent to apogee. Calculated doses for the missions were within a factor of 2.5 of the measured doses, with better agreement in the calculations for the more thinly shielded sensors. The differences between the calculated and measured doses are, for the most part, attributed to errors in the model environment. The analysis of the Apollo 4 and 6 data indicated that dose calculations for manned lunar missions which pass through the more intense portion of the trapped radiation belt would be reliable and that the expected doses are well below the planning operational dose limits set by NASA. (auth)

37369 METHOD OF DETERMINING THE ATMOSPHERIC SODIUM CONCENTRATION FROM TWILIGHT OBSERVATIONS. Kvifte, G. I.; Wallace, L. (Kitt Peak National Observatory, Tucson, Ariz.). Planet. Space Sci.; 18: 623-35(Apr 1970).

Simple formulae are given for computing the simultaneous amount of sodium in the twilight and the daytime sky from one set of observations of the D1 and D2 line intensities in twilight. The formulae are derived from an approximate solution of the transfer equation for a plane parallel atmosphere and conservative isotropic scattering. The accuracy of the formulae is compared with results obtained by calculating the sodium twilight emission rate using Chandrasekhar's (1950) X and Y functions for the same problem and taking into account the overlapping of the hyperfine lines composing the two sodium lines. For reasonable optical depths of the sodium the simple formulae agree with the more sophisticated calculations within about 5%, i.e., well within the accuracy of the present technique of measuring airglow line intensities. The formulas are therefore suited to an easy and sufficiently accurate reduction of twilight sodium data. (auth) (UK)

37370 DEPARTURES FROM JEANS' ESCAPE RATE FOR H AND He IN THE EARTH'S ATMOSPHERE. Brinkmann, R. T. (California Inst. of Tech., Pasadena). Planet. Space Sci.; 18: 449-78(Apr 1970).

It has long been recognized that thermal, or gravitational, escape must perturb the velocity distribution function of an escaping species so that Jeans' classic escape rate cannot be strictly correct. The magnitude of the appropriate correction remained unknown. Three recent statistical (Monte Carlo) investigations of this problem produced such discordant correction factors as to prompt yet another such study, reported here. Major differences in approach are (1) realistic atom–atom elastic scattering cross sections are used instead of an isotropic approximation and (2) program efficiency is increased dramatically by studying the virtual trajectories of atoms missing from the atmosphere instead of the real atoms comprising the atmosphere. Excellent agreement is achieved with one of the previous investigations; the escape rates of hydrogen and helium from the Earth's atmosphere are typically 70 to 75% and 97 to 99% of the Jeans rate, respectively. (auth) (UK)

37371 ORIGIN AND STRUCTURE OF THE PERMANENT MAGNETIC FIELD IN THE MAGNETOSPHERE AND INTERPLANETARY SPACE. Crifo, J. F. (Centre National de la Recherche Scientifique, Verrieres-le-Buisson, France). Rev. Phys. Appl.; 5: 195-207(Feb 1970). (In French). (CONF-690529-2).

From International Symposium on Measuring Techniques for Low Magnetic Fields in Space Research and in Geophysics, Paris.

The structure of the magnetic field in interplanetary space is determined by the expansion of the solar corona (solar wind) as well as by the instantaneous state of the photospheric magnetic field. The interaction between the magnetospheric field and the solar wind is studied. It determines the shape of the magnetospheric cavity and the configuration of the field in the external regions. A short survey of the interaction of the solar wind and the Moon is made. (tr-auth) (France)

37372 AC AND DC MAGNETIC FIELDS IN INTERPLANETARY SPACE AND NEAR THE EARTH. Gendrin, R. (Centre National de la Recherche Scientifique, Saint-Maur-des-Fosses, France). Rev. Phys. Appl.; 5: 209-20(Feb 1970). (In French). (CONF-690529-3).

From International Symposium on Measuring Techniques for Low Magnetic Fields in Space Research and in Geophysics, Paris.

The principal characteristics of the geomagnetic field of the Earth are reviewed, and it is shown that the sensitivity of the equipment is not the most important problem at the moment, at least for measuring continuous magnetic fields at the surface of the Earth. On the contrary, interplanetary measurements need sensitivities higher than 10^{-6} gauss. The mean spectral intensity of natural electromagnetic noise in the ulf (10^{-2} to 10 Hz) and the vlf (10^{-1} to 10 kHz) ranges is rapidly decreasing with frequency. Therefore, the problem of sensitivity and bandwidth of the receiver system is a problem even in the near vicinity of the Earth. Principal aspects of these natural phenomena are reviewed from the point of view of both their propagation characteristics and their generation mechanisms. Technical aspects are also described and special attention is given to problems that arise when measurements of low-intensity magnetic fields (ac or dc) in space are needed. (tr-auth) (France)

37373 RELATION BETWEEN ELECTRON PRECIPITATIONS AND PULSATIONS OF THE MAGNETIC FIELD. Treilhou, J. P.; Laffont, J.; Cambou, F. (Univ., Toulouse). Rev. Phys. Appl.; 5: 221-6(Feb 1970). (In French). (CONF-690529-4).

From International Symposium on Measuring Techniques for Low Magnetic Fields in Space Research and in Geophysics, Paris.

Two auroral events were studied in detail. For both of them the electron precipitation occurs about 25 min before the Pi1 and Pi2 pulsations. The amplitudes of the Pi2 pulsations and the electron precipitation reach a maximum in the same time interval. An interpretation of those phenomena is given. For pearl magnetic micropulsations with periods of 3 to 5 sec, a parallel evolution of the amplitudes of the micropulsations and of the electron flux, with a 6 min time difference, was revealed. Those hydromagnetic emissions could initiate the precipitation and make it regular. (tr-auth) (France)

37374 COMPARISON OF 100-kHz PULSE PROPAGATION DURING TWO SOLAR ECLIPSES. Doherty, R. H. (ESSA Research Labs., Boulder, Colo.). Nature (London); 226: 1129 (20 Jun 1970).

References are made to the July 1963 eclipse, the path of which swept across the Aleutian Islands, and the eclipse of March 7th 1970 over USA and Canada. During the former eclipse, 100-kHz pulse transmissions of the US Coast Guard Alaskan Loran-C chain were observed in the one-hop sky-wave propagation mode for paths near totality regions, and comparisons are made of the data obtained during that eclipse with those similarly made at the March 7th event. In the 1963 data the phase of the ionospheric signal was retarded nearly in proportion to the increasing solar obscuration, indicating a maximum apparent reflection height near maximum obscuration. Following maximum obscuration the phase advanced with an overshoot at the end of the eclipse. The amplitude of the lf pulse signal increased rapidly near totality and reached a maximum 4 min after totality. During the March 1970 eclipse lf pulse observations were made over several totality or near totality paths. The behavior during the latter eclipse was quite different from that of July 1963. Rather rapid phase retardations were observed near totality, with the maximum apparent height of reflection occurring 5 min after totality. The amplitude change was small, with maximum signal level occurring slightly before totality. In the case of the March 1970 event a solar flare occurred less than 1 hr before the eclipse started, and this may have partly accounted for the amplitude maximum occurring before maximum obscuration. The differences might have been concerned with the time in the solar cycle, different locations or path lengths for the measurements, or the season of the year, and these possibilities are examined. (UK)

37375 TRAVELLING IONOSPHERIC DISTURBANCES IN ATHENS DURING THE MARCH 7th SOLAR ECLIPSE. Anastassiadis, M.; Moraitis, G. (National Observatory, Athens). Nature (London); 226: 1125-6(20 Jun 1970).

It has been stated that a solar eclipse, by interfering with the heat balance in the shaded part of the atmosphere, could be expected to generate internal gravity waves that should be detectable at a considerable distance from the eclipse path. Measurements at Athens several days before, after, and on the eclipse day showed some unusual variations of f_0F2 and of h min F. Any attempt to associate these observations with the total eclipse over North America and Canada is, however, premature and only systematic observations from ionosondes and microbarographs around the world would justify a conclusion that the travelling disturbances were due to an eclipse effect. (UK)

37376 ELECTRON ENERGY LOSS FACTOR IN THE D REGION DURING THE ECLIPSE OF MARCH 7th 1970. Kissick, W. A. (Pennsylvania State Univ., University Park). Nature (London); 226: 1119-21(20 Jun 1970).

Experimental observation of the electron energy loss factor (G) in the D region during the eclipse is described. This factor is important for the reduction of interaction and other experiments, and enters the theory by way of the electron energy balance equation, which is used to obtain the excess electron energy, above ambient, imparted by a radio wave; it represents the mean excess energy loss by an electron for collision. The experimental technique was a variation of a "disturbing-before-wanted" (DBW) experiment

used by Smith et al. (unpublished). The disturbing pulse is transmitted before the wanted pulse and the amplitude and phase interaction coefficients are plotted as a function of the time spacing between the two pulses. Using a catalogue of DBW simulation, G can be determined without a knowledge of the electron density collision frequency. Use of both the extraordinary (X) and ordinary (O) mode disturbing wave gives a method of obtaining G with greater reliability than is possible with either mode alone. Seasonal variations in G are discussed, and average amplitude and phase interaction coefficients for June 1969 as compared with January 1970 are shown. During June 1969 G was between 3.5×10^{-3} and 5×10^{-3}, and during January 1970 between 2.0×10^{-3} and 3.5×10^{-3}. The experiment was run during the eclipse to look for a possible drop in the D-region temperature, which would show as an increase in G. It is concluded that if there was a G change it was probably no more than 0.3×10^{-3}, and that this would imply a D-region temperature drop of about 10°K. Changes in N may have complicated the results. (UK)

37377 PRELIMINARY RESULTS OF A RADIO-ABSORPTION STUDY AT 3.5 MHz. Kennedy, J. R.; Schauble, J. J. (Univ. of Florida, Gainesville). Nature (London); 226: 1118-19(20 Jun 1970).

The D region of the ionosphere is the main absorbing layer for radio waves, and any phenomenon which depletes the D-region ionization, such as a solar eclipse, will decrease absorption; on the other hand a solar flare will increase absorption. These effects, therefore, can throw light on D-region processes. A continuous-wave experiment at 3.57 MHz, conducted during the March 7th 1970 eclipse in order to study the influence of the eclipse on absorption, is described. A 75-W transmitter was set up at Waycross, Georgia, near the center of the region of totality, with a receiving station in Florida, 190 km to the SW and also along the totality path. The arrangement was such as to avoid any possibility of contamination of the desired sky-wave signal with ground waves and also to avoid appreciable attenuation of the sky-wave. The signal level was sampled about every 10 min on the eclipse day, except for the period near totality when the interval was 1 to 2 min. The relative absorption on March 7th is shown as compared with the mean for control days. A solar flare occurred on the morning of the eclipse and a significant increase in absorption induced by the flare radiation was seen. Also shown is the evolution of the solar flare as seen in the 1 to 8-Å x-ray band from the Solrad satellite; a strong correlation between the x-ray flux and the observed absorption is evident. After an approximate correction for the effect of the flare it was found that the maximum change in absorption produced by the eclipse was of the order of 14 to 15 dB, in good agreement with other measurements. Some anomalies are also discussed. (UK)

37378 STEEP-INCIDENCE D-REGION REFLEXIONS OF LOW-FREQUENCY PULSES DURING THE MARCH 7th 1970 ECLIPSE. Wieder, B.; Espeland, R. H. (Inst. for Telecommunication Sciences, Boulder, Colo.). Nature (London); 226: 1117-18(20 Jun 1970).

Observations are reported from the Loran-C transmitter at Cape Fear, N. Carolina, near the path of eclipse totality. Loran-C transmissions are pulsed, with a carrier frequency of 100 kHz, a nominal bandwidth of 20 kHz, a nominal peak radiated power of 400 kW, with vertical polarization. The complete pulses of the ground wave and the once-reflected sky-wave signals were recorded by synchronised averaging techniques at a site 48.87 km west of the transmitter. The data were spectrum analyzed and the normally reflected and abnormally reflected sky-wave amplitudes at several frequencies in the Loran-C frequency band were derived, and ionospheric reflection coefficients were deduced from the data. The magnitude of the normalized sky-wave amplitudes for five frequencies is shown as a function of time during the eclipse, together with the angle-of-arrival data of the sky-wave. The most striking feature is the oscillatory nature of the normalized sky-wave amplitudes; it is believed that this feature results from interference between signals reflected from different levels in the D region. In a stratified ionosphere likely contributors to partial reflections are those levels in the D region where a layer of enhanced or diminished ionization exists within what would otherwise be a monotonically increasing ionosphere; that such layers occur is indicated by angle-of-incidence data. Periodically, the high frequencies show angles of arrival considerably smaller than the low frequencies; this can be interpreted in terms of a two-layer D region, the low frequencies being reflected by a lower layer, whilst the high frequencies penetrate the lower layer and are reflected by the upper layer. The angle-of-arrival results were unexpected; they indicate that the different frequencies comprising the pulse appear to arrive from different parts of the sky. The height of reflection may, however, appear to be lower than that at which the actual reflection process occurs. It is assumed that the D region can be considered horizontally stratified; for a tilted or rough region it would be very difficult to interpret the data. It is the intention to derive from the data as much detailed information as possible about D-region structure. (UK)

37379 OBSERVATIONS OF IONOSPHERIC ELECTRON CONTENT DURING THE MARCH 7th 1970 SOLAR ECLIPSE. Almeida, O. G.; da Rosa, A. V. (Stanford Univ., Calif.). Nature (London); 226: 1115-16(20 Jun 1970).

Faraday rotation measurements of the vhf transmission from the geostationary satellites ATS-I and III were made at several observatories in the U.S.A. during the eclipse, and at Eastville, Virginia (near Wallops Island). Changes in the difference of the vhf and uhf phase path length between the ground and ATS-III were also measured. The path of this satellite crossed an eclipsed part of the F region. Such measurements can be simply related to electron content, and a graph of electron content versus time for Eastville is shown, at which location the bulk of the ionosphere was totally eclipsed. A pronounced "bite-out" was observed, estimated as about 20×10^{16} electrons/m^2 (~30%), and a 35-min delay was observed between the time of minimum electron content and that of totality. The slab thickness behaved in an interesting fashion; some minutes prior to first contact it had a value of 430 km which persisted up to 30 min before the maximum of totality, at which point it fell rapidly to 422 km at mid-totality, probably due to wiping out of the E layer; it then rose sharply to 480 km at the time the electron content was at a minimum and again decayed to some 400 km after the fourth contact. In the time interval between totality and fourth contact there was a sharp dip to 440 km followed by a recovery to 470 km. Since the cooling of the upper ionosphere expected during the eclipse would reduce the slab thickness, the observed increase may have been due to marked erosion of the O^+ layer and consequent lowering of the $O^+ - H^+$ transition height. The "bite-out" at stations away from the path of totality was surprisingly low. From the Eastville measurements both the columnar electron content and its time derivative were calculated, together with the linear loss rate and estimates of the integrated production rate. It is pointed out that determination of the linear loss rate from Faraday rotation measurements presents several difficulties not found with the phase path length technique, and sources of error are discussed. The use of Faraday rotation angle alone for determination of the mean recombination coefficient may lead to errors of the order of 100%. It is hoped that by further data analysis useful information concerning layer changes induced by the eclipse can be derived. (UK)

37380 VARIATION OF ELECTRON DENSITY IN THE D REGION. Rowe, J. N.; Ferraro, A. J.; Lee, H. S. (Pennsylvania State Univ., University Park). Nature (London); 226: 1116-17(20 Jun 1970).

Measurements made during the solar eclipse of March 7th 1970 are reported, using the wave-interaction technique (Lee and Ferraro, J. Geophys. Res. 74: 1184(1969)). Obscuration was about 90% at Pennsylvania State University. The time to obtain a profile was about 7 min; this time could have been shortened to about 2 min, but as the interaction effect was expected to decrease during the eclipse the long integration time was adopted to improve the signal-to-noise ratio; also rapid changes in electron density were not expected since the eclipse was only partial. An experiment to measure the electron energy loss coefficient was also performed after every third electron density measurement. Electron density profiles are reproduced. The chief eclipse effect appears to have been above 70 km, with the electron density at lower heights remaining approximately constant until after the eclipse. Interpretation of the results in terms of D-region chemistry is discussed. (UK)

37381 SYNOPTIC PREVIEW OF IONOSPHERIC DATA TAKEN AT FORT MONMOUTH, NEW JERSEY, DURING THE ECLIPSE OF MARCH 7th 1970. Arendt, P. R.; Gorman, F.; Soicher, H. (Inst. for Exploratory Research, Fort Monmouth, N. J.). Nature (London); 226: 1114(20 Jun 1970).

Observations made at Fort Monmouth included a readout from the topside sounder satellite Alouette I, polarization and signal strength measurements from beacons in the S-66 and ATS-3 satellites, and bottomside ionograms from various locations. This communication discusses how data from the ATS-3 observations are related to the vertical ionogram data obtained from Wallops Island. The polarization measurements of the ATS-3 beacon (137.35 MHz) gave the expected picture for a solar eclipse close to local noon; before first contact the polarization angle (total electron content) steadily increased until a turning point or maximum was reached, after which the values decreased to a minimum related to the maximum coverage of the eclipse. After this minimum an increase was observed until a second maximum was observed, the polarization thereafter decreasing as

expected during the afternoon of a disturbed day. A similar variation was observed for the plasma frequencies read from the ionograms. The first turning point in the ATS-3 observations (the moment when the effects of decreasing ionization were noticed in the total electron content) was about 13 min after first contact. The effect of the eclipse was shown in the total electron count along the path of the satellite about 4 min earlier than in the F-region observations, and the early decrease of E_0 before the beginning of the decrease in total electron content appears to be compatible with the later reaction of the F region. The Wallops Island data also indicated that the E region responds more quickly. The data were consistent in so far as the comparison of F-region data with total electron content data is concerned, but the reaction of the E region appears to be advanced in time relative to changes in illumination; this might be related to the distribution of zones of x-ray activity. (UK)

37382 COMPARISON OF CHANGES IN TOTAL ELECTRON CONTENT ALONG THREE PATHS. Klobuchar, J. A.; Malik, C. (Air Force Cambridge Research Labs., Bedford, Mass.). Nature (London); 226: 1113-14(20 Jun 1970).

The total electron content (TEC) of the ionosphere during the March 7th 1970 solar eclipse was measured along paths towards three geostationary satellites from a ground station at Hamilton, Mass. (96% eclipse) by monitoring the amount of twist of the polarization of linear, attitude-stable, vhf radio waves transmitted from the geostationary satellites Early Bird, ATS 3, and ATS 5. The amount of polarization twist is proportional to the integrated product of the electron density and the longitudinal component of magnetic field intensity. The maximum change in TEC from the mean of the three days preceding the eclipse was approximately −30%, and the time delay from the time of maximum optical obscuration to the observed minima in TEC along the three paths was about 20 min. Vertical incidence ionosondes also observed density decreases of about 30% at the peak of the F region. The equivalent slab thickness of the F region was not significantly changed during the eclipse. In spite of the fact that the solar eclipse occurred during a moderately disturbed period, the eclipse effects were clearly predominant. It was also interesting that the TEC and N_{max} changed by approximately the same amount, indicating that the expected piling up of electrons from higher heights to near the peak was more than compensated by losses at the peak, such that the layer shape was maintained. (UK)

37383 CHANGES IN THE ELECTRON CONTENT OF THE IONOSPHERE. Bienstock, B. J.; Marriott, R. T.; St. John, D. E.; Thorne, R. M.; Venkateswaran, S. V. (Univ. of California, Los Angeles). Nature (London); 226: 1111-12(20 Jun 1970).

It is stated that the observed rapid response of the E region to an eclipse is a direct consequence of the short electron recombination times at these heights (~90 sec). In the F region, however, these recombination times become large (several hours) and the observed eclipse effects are controlled by plasma transport; the chief purpose of the experimental work described was to investigate this transport. The Faraday rotation introduced by the ionosphere on the 137-MHz transmissions of two geostationary satellites, ATS-I and ATS-III, located respectively at 150° and 80°W, was measured under the March 7th 1970 eclipse conditions. The measured Faraday rotation can be related simply to the electron content. It was found that the electron content started to decrease after first contact, and that a minimum was reached approximately at the time of maximum obscuration, but that the maximum reduction occurred approximately 20 to 30 min later than the obscuration maximum. Reductions were significantly larger than those measured by other workers. In order to interpret the observed effects it is important to realize that the Faraday rotation technique is primarily sensitive to the F region and to the topside ionosphere, which accounts for approximately 80% of the total electron content, and because of the large recombination times at these heights the observed rapid changes in content clearly demonstrate the importance of ionization transport. Such transport is promoted by the rapid decrease of electron temperatures, and to a lesser extent of ions, in the topside ionosphere. This transport is essentially aligned with the geomagnetic field, and the observed extent of electron reduction therefore depends on the relative orientation of the geomagnetic field and the lines of sight to the satellites. A detailed analysis is being undertaken, which should enable development of a model for ionization transport in the topside ionosphere. (UK)

37384 ECLIPSE EFFECTS IN THE IONOSPHERE. Rishbeth, H. (Radio and Space Research Station, Slough, Eng.). Nature (London); 226: 1099-1100(20 Jun 1970).

A survey is given of recent trends in the study of the effects of solar eclipses on the ionosphere under the following headings: production and loss of ionization in the lower ionosphere; transport processes in the F region; F-region temperature changes. (UK)

37385 ATTI DEL XVI CONVEGNO ANNUALE, NAPOLI, 22-24 MAGGIO 1967. ASSOCIAZIONE GEOFISICA ITALIANA. (Proceedings of the 16th Meeting, Naples, May 22-24, 1967. Italian Geophysics Society). Ass. Geofis. Ital., Atti Conv. Annu.; 16: 1-598(May 1967). (In Italian and English). (CONF-670532).

Separate abstracts were prepared for 4 of the 40 papers included. The remaining 36 papers are outside the scope of NSA. (J.W.R.)

For abstracts of individual papers see: 36422, 37139, 37386, and 38386.

37386 ORIGIN OF DAY-SIDE POLAR AURORAE. Gregori, G. P. (Centro Nazionale di Fisica dell'Atmosfera e Meteorologia, Rome). Ass. Geofis. Ital., Atti Conv. Annu.; 16: 525-36(May 1967). (In Italian).

From 16th Annual Conference of Italian Geophysical Society, Naples, Italy. See CONF-670532.

The possibility that day-side auroras originate from the tail of the magnetosphere is discussed. It is assumed that some pressure (hydromagnetic or other) is actually responsible, or at least co-responsible, for the formation of the tail. Under this assumption, a model is tentatively suggested and discussed, Further to the "neutral sheet," a "polar neutral sheet" could exist. The implications of such a model for the particle injection and acceleration in the magnetosphere are considered. It is shown that, even by a very general and qualitative argument, it is possible to explain the seasonal behavior of the auroral frequency distribution. The possibility to test such a model is also discussed. (auth)

37387 RESPONSE OF THE F-REGION IONOSPHERE TO A SOLAR ECLIPSE. Flaherty, B. J.; Cho, H. R.; Yeh, K. C. (Univ. of Illinois, Urbana). Nature (London); 226: 1121-3 (20 Jun 1970).

Measurements of the Faraday rotation of a linearly polarized signal have been widely used as a means of obtaining the integrated electron density or electron content in the ionosphere, and some preliminary results are presented using this technique during the March 7th 1970 solar eclipse, employing signals transmitted by the geostationary satellite ATS-3 at 137 MHz. Continuous observations were made at Norfolk, Virginia, Turkey Point, Florida, and Urbana, Illinois, but only the Norfolk (36.56°N, 72.24°W) data are given. It is pointed out that polarimeter measurements give only relative changes in polarization, and that the daytime content is not very sensitive to the exact value of the transmitted polarization. The average diurnal variation in electron content, as well as the eclipse day variation, are shown. The content increased for about 40 min after first contact, and then started to decrease when the Sun was about 40% eclipsed. The minimum was reached 39 min after totality, the content then returning to its normal value about 43 min after fourth contact. The change in content from first maximum to minimum was 12.8×10^{16} electrons/m^2 (decrease of 22.5%), and the change from the minimum to second maximum was 8.5×10^{16} (increase of 19.5%). In order to simulate the eclipse behavior of the F-2 region the ionization equation of continuity and the neutral equation of motion were solved. Perturbations introduced during the eclipse, and the computation results, are discussed. It was assumed arbitrarily that the decrease of the exospheric temperature was proportional to the eclipse function and that the maximum exospheric temperature drop was 10% of the minimum nighttime temperature provided by Jacchia's model of the neutral atmosphere. A 1-hr time delay between the time of maximum energy input and the time of maximum temperature of the atmosphere was introduced; no time delay was introduced for the temperatures of charged particles. A dynamo electric field was also included in the computations, and this was assumed to be unaffected by the eclipse. Comparisons are made between the data obtained at Norfolk and computations for a station at 33.87°N, 77.07°W; differences were found which were difficult to reconcile, but it is emphasized that the effect on the electric field was not taken into account, and other factors may have to be modified as more eclipse data become available. (UK)

37388 VLF RADIO SIGNALS OBSERVED IN NEWFOUNDLAND DURING THE SOLAR ECLIPSE OF MARCH 7th 1970. Rycroft, M. J.; Reeve, C. D. (Univ. of Southampton, Eng.). Nature (London); 226: 1126-7(20 Jun 1970).

A preliminary report is presented on some naturally occurring radio signals observed from Newfoundland in the vlf band between 1 and 10 kHZ during the eclipse. Whistlers were not recorded

during the eclipse, but some interesting phenomena were found. A single-turn square loop antenna, of side 3m, was used, mounted with its plane vertical in the magnetic E–W direction; signals from radio and other transmitters were removed by appropriate filters, together with interference associated with power lines, and a special circuit minimized the effort of atmospherics. The amplified vlf waveform was recorded on magnetic tape, and fluctuations in the N–S horizontal component of the Earth's magnetic field were also recorded, using a flux-gate magnetometer. A chart recording for a 10-hr period on the eclipse day is shown. There was no definite evidence for a decrease in magnetic field that could be attributed to a change in currents flowing in the dynamo layer of the ionosphere; vlf emissions of the chorus type were recorded; these were particularly strong in the 2.9-kHz band. Subsequently, the predominant signals were "tweeks," which are atmospherics that have propagated for a considerable distance in the waveguide formed by the Earth and the nighttime ionosphere. Some 30 min after commencement of the eclipse, the intensity of the vlf signals increased. "Tweeks" persisted for nearly an hour, indicating that electrons in the lower ionosphere quickly recombined, the electron density falling to a post-sunset value. Nighttime propagation conditions existed. An unexpected phenomenon was the observation of a sequence of intense, rising-frequency musical tones "risers." Eighteen "risers" were recorded within 2¼ min. Some weaker "risers" were also recorded. Nearly all these "risers" occurred at times when the magnetic field was rapidly decreasing, and it is probable that they were produced by a transverse plasma instability in the magnetosphere. It is suggested that they were received at ground only at times close to eclipse totality because of the then much reduced electron density and absorption of the D-region. Some other peculiar vlf emissions, with both rising and falling frequency-time characteristics, were also received, some characteristic of "hiss." (UK)

37389 VLF PROPAGATION EFFECTS PRODUCED BY THE ECLIPSE OF MARCH 7th 1970. Schaal, R. E.; Mendes, A. M.; Anathakrishnan, S.; Kaufmann, P. (Machenzie Univ., Sao Paulo, Brazil). Nature (London); 226: 1127-9(20 Jun 1970).

A study is described of some vlf transmissions from three locations (Haiku, Seattle and Maine) as received at Sao Paulo during the eclipse by two receiving stations controlled by a rubidium oscillator. The recording time constants were 50 sec in phase and in amplitude, and the propagation paths were 12900, 10900, and 7900 km, respectively. The effect of the eclipse on the Maine–Sao Paulo path is shown, including observed phase changes; the maximum phase delay was 4.5 μsec, occurring nearly 5 min after totality, and the interval between the onset of phase retardation and first contact was 11 min. Tracking procedures are described. A sudden ionospheric disturbance (SID) affected the phase and amplitude of both Haiku and Seattle signals, some consequences of which are menticned. Changes in amplitude were, in general, small, the maximum increase being <0.3 dB. Phase changes on the Seattle–Sao Paulo path are also shown, and the effect of the SID is clearly seen. The amplitude recovered to normal after the SID, and the commencement of the eclipse effect could be seen clearly. The maximum phase change was about 4.5 μsec and the delay between phase maximum and totality was about 9 min. Amplitude changes were again very small. With regard to the Haiku–Sao Paulo path, the SID occurred 45 min after first contact, and it was interesting to observe that the effect due to the eclipse had already begun before the SID occurred. It should be possible, in principle, to determine from the data the location of the active region on the Sun responsible for the x-ray emission. A maximum phase retardation of about 5μsec was observed at 10.2 kHz on the Haiku–Sao Paulo path. All the observations appear to confirm Hildebrand's conclusion that there seems to be no distinguishable frequency dependence in the amount of phase advance. (UK)

Low-Temperature Physics

Refer also to abstracts 37592, 37977, and 38512.

37390 (NP–18294) ELECTROLYTIC DEPOSIT OF A LEAD LAYER FROM A LEAD TETRAFLUOROBORATE BATH FOR SUPERCONDUCTING CAVITY RESONATORS. Guenzel, D.; List, L. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Experimentelle Kernphysik). Mar 1970. 54p. (In German). Dep. CFSTI (U. S. Sales Only).

The surface residual resistance of superconductors in the GHz region is extremely sensitive to surface treatments. In particular, production of lead surfaces by electroplating must be done with great care. In order to find correlations between the parameters of the plating bath and the surface residual resistance, the lead plating with a $Pb(BF_4)_2$ bath was studied systematically. (auth)

37391 (NP–18295) ON THE INTERACTION OF RF FIELDS WITH MECHANICAL PROPERTIES OF METALS. Halbritter, J. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Experimentelle Kernphysik). Mar 1970. 37p. Dep. CFSTI (U. S. Sales Only).

The interaction between rf fields and mechanical properties is discussed. Results show that the phonons generated by the rf fields in fissured surfaces are able to explain the temperature-independent residual rf losses of shielded lead-plated copper or massive niobium cavities. Besides the losses there exists a large frequency shift proportional to the stored energy of the cavity, which is caused by a deformation of the wall by the radiation pressure. (auth)

37392 MOMENTUM CONSERVATION, TIME-DEPENDENT GINZBURG–LANDAU EQUATION, AND PARACONDUCTIVITY. Eilenberger, Gert (Univ. of Helsinki). Z. Phys.; 236: 1-13 (1970).

Superconductors exhibit increasing electrical conductivity as the temperature approaches T_c from above, due to superconducting fluctuations. The functions $\sigma_{fl} = \sigma(\omega, \epsilon) - \sigma_n(\omega)$, $\epsilon = (T - T_c)/T_c$ have been derived by Schmidt phenomenologically using the time-dependent Ginzburg–Landau equation (TDGL). These functions fail to vanish in the absolute clean limit $\tau \to \infty$ as they should. The author has reinvestigated the derivation of the linearized TDGL-equation and the corresponding current expression in the presence of a time-dependent vector potential. Several new terms are found, which are important for the rather clean superconductor only and are easily interpreted physically in terms of momentum conservation. Applying these corrected equations to the paraconductivity problem, $\sigma_{fl}(\omega, \epsilon)$ is derived, which has an extra factor $(1 - i\omega\tau)^{-2}$ compared to Schmidt's result. There is also an additional term, which is connected to the problem of the contribution calculated by Maki. By comparison with the linear response function below T_c, it is shown that this term is valid in the limit $|\omega| \gg |\Delta|$ only and may not be continued to $\omega = 0$. There remains, however, a problem connected with this term, which cannot be solved within the present phenomenological framework. (auth)

37393 CRITICAL CURRENT AND MAGNETIZATION OF HOMOGENEOUS TYPE-II SUPERCONDUCTOR IN LONGITUDINAL STATIC MAGNETIC FIELD. Sugahara, Masanori (Yokohama National Univ., Japan). Jap. J. Appl. Phys.; 9: 625-30(Jun 1970).

Calculations are carried out on the internal flux-density distribution and the upper limit of the internal current density of homogeneous type-II superconductor in a longitudinal field. The characteristics of the critical transport current obtained by use of the calculated results display a good coincidence with those of the experimentally observed critical current. It is emphasized that such a superconductor in a longitudinal field will become important in engineering for its capability of transporting fairly large alternating current stably and with negligible power dissipation. (auth)

37394 ELECTROMAGNETIC PROPERTIES OF SUPERCONDUCTORS WITH STRONG COUPLING. Geilikman, B. T.; Kresin, V. Z. (Moscow State Correspondence Teacher's Inst.). Dokl. Akad. Nauk SSSR; 182: 1040-3(11 Oct 1968). (In Russian).

The energy gap in strongly coupled superconductors and their thermodynamic and kinetic properties were studied previously. Studies were continued in order to determine electromagnetic properties of anomalous superconductors in an arbitrary magnetic field near T_c. The Ginzburg–Landau equations are derived, the depth of weak field penetration is calculated, and electromagnetic properties of strongly coupled Pb–Tl and Pb–In alloys were determined. (R.V.J.)

37395 MANOSTAT FOR TEMPERATURE REGULATION OF CRYOSTATS. Nagy, J.; Novak, D. ATOMKI (At. Kut. Intez.) Kozlem.; 11: 187-90(Dec 1969). (In Hungarian).

The manostat, made of a 0.2-mm thick synthetic material membrane, is capable of ensuring in the cryostat a temperature stability of $\pm 5 \times 10^{-3}$ grad and $\pm 5 \times 10^{-4}$ grad at the boiling point of liquid N_2 and neon, respectively. (auth)

37396 PENETRATION DEPTHS IN PURE SUPERCONDUCTING NIOBIUM. Tang, I-ming (Reed Coll., Portland, Oreg.). Phys. Lett., A; 32: 185-6(9 Jun 1970).

Using the mass ratio m_d/m_s obtained from the band calculations on niobium, the temperature variation of the penetration depths in the purest superconducting niobium is obtained. The curve for the purest niobium lies far below those previously obtained. (auth)

37397 POSSIBLE EXISTENCE OF PAIR-CONDENSATE IN SUPERFLUID HELIUM. Wong, K. W. (Univ. of Southern California, Los Angeles). Phys. Lett., A; 32: 195-6(9 Jun 1970).

The lower critical velocity of quantized vortex rings found by Cunsolo and Maraviglia is analyzed on the assumption that pair-condensate exists in superfluid helium. The experimental results are found to agree to within experimental error with the theoretical model proposed earlier. (auth)

37398 SUBHARMONIC STRUCTURE IN SUPERCONDUCTING TUNNELING. Giaever, I.; Zeller, H. R. (General Electric Research and Development Center, Schenectady, N. Y.). Phys. Rev., B; 1: 4278-88(1 Jun 1970).

The current–voltage characteristic obtained in a tunneling experiment between two equal superconductors often contains structure at $2\Delta/n$ where 2Δ is the energy gap and n is an integer. The origin of this subharmonic structure has never been satisfactorily established; however, it has often been linked with the Josephson effect. This subharmonic structure was studied experimentally and three new results were obtained: (1) the magnitude of the structure can be made to increase proportionally to the square of the tunneling matrix element; (2) the structure is very sensitive to externally applied microwave radiation; (3) when two dissimilar superconductors a and b are used, the structure appears at $2\Delta_a/2n$, $2\Delta_b/2n$, and $(\Delta_a + \Delta_b)/(2n + 1)$. These experimental results strongly support the idea that the structure is caused by the self-detection of the Josephson radiation. To explain the magnitude of the structure, it is necessary to assume that the tunneling matrix element is so large that it is improper to linearize the Josephson equations. (auth)

37399 CRITICAL CURRENTS IN SUPERCONDUCTING TIN AND INDIUM. Scharnhorst, Peter (Naval Ordnance Lab., Silver Spring, Md.). Phys. Rev., B; 1: 4295-4304(1 Jun 1970).

The critical current densities in planar superconducting films of tin and indium were determined as a function of temperature by using a new method. An alternating current in a flat ribbon-shaped drive loop was imaged in the superconducting film. Both tin and indium films were deposited at 80°K and were annealed to temperatures between 80 and 180°K. The temperature dependence of $J_c(t)$ was found to be $(1 - t^2)^{\alpha}(1 + t^2)^{\frac{1}{2}}$, where $\alpha = 1.23$ for tin and $\alpha = 1.16$ for indium. (auth)

37400 ULTRASONIC ATTENUATION IN DIRTY SUPERCONDUCTORS. Guermeur, R.; Joffrin, J.; Levelut, A. (Faculte des Sciences, Paris). Phys. Rev., B; 1: 4304-7(1 Jun 1970).

Experimental support for the theory of the attenuation α of ultrasonic waves in dirty superconductors was obtained with 10-GHz longitudinal waves in mercury–indium alloys. α varies as $H_{c2} - H$ near H_{c2} and the slope $\Delta\alpha/\Delta H$ has the predicted value. (auth)

37401 FLUX CONSERVATION IN MULTIPLY CONNECTED TYPE-I SUPERCONDUCTORS IN FIELDS GENERATED IN THE VOIDS. Schweitzer, Donald G.; Garber, M. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., B; 1: 4326-30(1 Jun 1970).

The behavior of multiply connected type-I superconductors in magnetic fields generated in the voids can be accounted for quantitatively by assuming flux conservation within the total system rather than in the void alone. The properties are similar to the "anomalous" properties observed when hollow cylinders are cooled in static fields and do not appear to involve intermediate-state formation. The results and analysis of the results show that in these configurations the transition from the pure superconducting state to the normal state occurs through a single sharp S–N boundary which begins at the inside wall and moves to the outside wall with increasing solenoid current (or internal field). This interface moves reversibly, both with increasing and decreasing field and with increasing and decreasing temperature. Such an interface is not associated with hysteresis in the bulk material and does not lead to field retention in the void when the solenoid current is reduced to zero. Field retention in the void and in the bulk, when the solenoid current is removed, occurs only after sufficient current is initially applied to drive the wall into the intermediate state. The effects also occur in hollow cylinders of unfavorable geometries (short thick walls) and provide a means of making unambiguous measurements of the velocity of the superconducting normal interface. (auth)

37402 ANOMALOUS PROPERTIES OF A NORMAL FERMI LIQUID AT LOW TEMPERATURES. Misawa, S. (Nihon Univ., Tokyo). Phys. Lett., A; 32: 153-4(9 Jun 1970).

The temperature dependence of the susceptibility of a Fermi liquid is shown to be of the form $a - bT^2\ln T$, and hence in the presence of a magnetic field the heat capacity varies as $T\ln T$ at sufficiently low temperatures. (auth)

37403 NOISE VOLTAGE IN JOSEPHSON JUNCTIONS. Kanter, H.; Vernon, F. L., Jr. (Aerospace Corp., El Segundo, Calif.). Phys. Lett., A; 32: 155-6(9 Jun 1970).

The theoretical prediction of voltage across Josephson junctions due to thermal noise currents is shown to be in reasonable agreement with experiments in which noise currents of variable "temperature" were produced by the radiation of a gas discharge. (auth)

37404 APPARENT HIGH-MAGNETIC-FIELD FLUCTUATION SUPERCONDUCTIVITY IN THE 2 TO 3 T_c RANGE. Hake, R. R. (North American Rockwell Corp., Thousand Oaks, Calif.). Phys. Lett., A; 32: 143-4(9 Jun 1970).

Measurements of the magnetic-field dependence of the electrical resistivity in bulk specimens of very-short-coherence-distance superconducting alloys suggest the presence of fluctuation superconductivity up to at least 3 T_c, and up to 40 kG in the vicinity of 2.5 T_c. (auth)

37405 SECOND SOUND IN ^{3}He–^{4}He MIXTURES NEAR THE λ POINT. Nobb, S. M.; Sandiford, D. T. (Manchester Univ., Eng.). J. Phys., C (London); 3: 123-5(Jun 1970).

The velocity of second sound in pure liquid ^{4}He and ^{3}He–^{4}He mixtures of 0.55%, 1.65% and 3.55% was measured, using a resonance method, within 100 mK of the λ point. The results may all be represented by the expression $U_{20}(1 - T/T_\lambda)^m$ where $m = 0.382 \pm 0.004$ for all mixtures. Using Dash and Taylor's modification of Pomeranchuk's theory of dilute mixtures, these results give a superfluid density proportional to $(T_\lambda - T)^{\frac{1}{2}}$ for all concentrations of ^{3}He, as previously found by other workers in pure ^{4}He. (auth) (UK)

37406 INFLUENCE OF MICROSTRUCTURE ON THE SUPERCONDUCTIVITY OF A DILUTE Ti–Mo ALLOY. Collings, E. W.; Ho, J. C. (Battelle Memorial Inst., Columbus, Ohio). Phys. Rev., B; 1: 4289-94(1 Jun 1970).

Low-temperature specific-heat studies have shown that the superconducting transitions of thermally and mechanically induced martensitic structures, in quenched Ti–Mo (4½ at. %), occur in the range 2.5 to 3.2°K, compared to an estimated 0.5°K for the undistorted material. It is concluded that these thermal and deformation martensites are examples of structures in which "soft-phonon" modes are operative to increase T_c above what would be expected for unfaulted lattices of similar compositions. (auth)

37407 MANY-BODY PROBLEM. Mallorca International School of Physics, August 4–22, 1969. Cruz, A.; Preist, T. W. (eds.). New York; Plenum Press (1969). 346p. $15.00.

Various aspects of the many body problems are considered. Green's functions for phonon problems including that of superfluids, kinematical properties of equilibrium states, mathematical structure of the BCS and related models, and functional integration methods in quantum mechanics are covered. Also covered are field equations and form-invariant renormalization, Bruckner theory for nuclear matter, coupled boson-fermion systems including meson-nucleon systems and plasmon resonances in the quantum strong field limit. (J.F.P.)

37408 ^{3}He CRYOSTAT FOR DYNAMIC PROTON POLARIZATION. Masaike, A.; Eisenkremer, M.; Glaettli, H. (CEN de Saclay, Gif-sur-Yvette, France). Rev. Sci. Instrum.; 41: 1090-1(Jul 1970).

A helium-3 cryostat for dynamic proton polarization studies below 1 K is described. The temperatures of the carbon resistor and a sample of ethylene glycol as a function of microwave power is presented graphically. (W.H.K.)

37409 TEFLON CELL FOR HIGH PRESSURE SUPERCONDUCTIVITY MEASUREMENTS. Kim, Kang Soo (Univ. of California, San Diego, La Jolla). Rev. Sci. Instrum.; 41: 1102-3(Jul 1970).

A Teflon cell for hydrostatic pressure generation for electrical and magnetic measurements at very low temperatures and high pressures is described. (W.H.K.)

37410 FLUX-TRANSPORT NOISE IN SUPERCONDUCTORS. Van Gurp, G. J. (Philips Gloeilampenfabrieken, Eindhoven, Netherlands). Rev. Phys. Appl.; 5: 83-6(Feb 1970). (CONF-690529–5).

From International Symposium on Measuring Techniques for Low Magnetic Fields in Space Research and in Geophysics, Paris.

Due to the quantized nature of flux in superconductors, devices making use of transport of flux exhibit intrinsic flux-transport noise. A discussion is given of power spectra of this noise, as measured on current-carrying ribbons of type-II and type-I superconductors. The noise level may be high in these ribbons because the flux moves as bundles of vortex lines, and number of flux quanta per bundle being greater for lower temperature, flux density, and current density and stronger vortex pinning. The measured power spectra can be accounted for by various distribution functions for the transit time of the vortex lines across the ribbon. Temperature fluctuations give rise to extrinsic noise, but this can be removed. (France)

37411 EFFECTIVE ^{3}He QUASIPARTICLE INTERACTION IN SUPERFLUID ^{4}He. Eckstein, S. G. (Technion-Israel Inst. of Tech., Haifa. Argonne National Lab., Ill.); Eckstein, Y.; Kuper, C. G.; Ron, Amiram. Phys. Rev. Lett.; 25: 97-100(13 Jul 1970).

The thermodynamic functions of dilute ^{3}He–^{4}He solutions are expressed in terms of the excess molar volume in a model-independent fashion. In this way the effective ^{3}He quasi-particle potential is found, without the assumption of Bardeen, Baym, and Pines. It is found that the term $-\alpha^2 m_4 s^2/n_{40}$ in the effective potential is completely cancelled, but that new terms of another form appear. (auth)

37412 QUALITATIVE EXPLANATION OF PELLAM'S HELIUM PARADOX. Penney, R. (Ford Motor Co., Dearborn, Mich.). Phys. Rev. Lett.; 25: 138-40(20 Jul 1970).

The temperature dependence of the torque on a Rayleigh disk immersed in rotating helium is explained qualitatively on the basis of superfluid dynamics. A heat-exchange torque peculiar to two-fluid mechanics arises due to the disk being bathed in ambient room-temperature radiation. (auth)

37413 I–V CHARACTERISTICS OF SUPERCONDUCTING TUNNEL JUNCTIONS. Albegova, I. Kh.; Borodai, B. I.; Yanson, I. K.; Dmitrenko, I. M. (Physical-Technical Inst. for Low Temperature, Kharkov). Sov. Phys.-Tech. Phys. (Engl. Transl.); 14: 681-5(Nov 1969).

Translated from Zh. Tekh. Fiz.; 39: 911-17(May 1969).

The shape of the I–V characteristics of a Josephson tunnel junction in a low-resistance circuit was studied experimentally and theoretically. It was found that the I–V characteristic has peaks with shapes that are distorted by relaxation oscillations in the circuit when the junction is operated on the negative slope of the peak. (auth)

37414 INVESTIGATION OF THE HOMOGENEITY OF SUPERCURRENTS IN LARGE SHEETS: RESULTS WITH NIOBIUM. Weber, R. (Siemens AG, Erlangen, Ger.). Z. Angew. Phys.; 29: 195-7(1970). (In German).

The homogeneous distribution of the supercurrent in annealed niobium sheets and their tendency towards flux jumps were investigated by means of a flux pump. (auth)

37415 ANALOG RELAXATION SOLUTION OF THE NONLINEAR GINZBURG–LANDAU EQUATIONS. Presson, A. G.; Fink, H. J. (Atomics International, Canoga Park, Calif.). Contract AT(04-3)-701. pp 59-62 of Analog and Hybrid Computation Applied to Nuclear Energy. Brussels, Presses Academiques Europeennes (1969).

From International Symposium on Analogue and Hybrid Computation Applied to Nuclear Energy, Versailles, France. See CONF-680941.

Boundary value solutions of the nonlinear Ginzburg–Landau equations have been obtained on the analog computer for both cylindrical and slab geometry. A relaxation technique was used to solve the sensitive two-point boundary problem. Parametric studies were made for the transition between the superconducting and normal state in a continuous manner for a fixed number of fluxoids when the applied magnetic field was used as an independently acting variable. The relaxation technique was automated on the computer to obtain a continuous input-output operation which was controlled by the applied magnetic field. Current, energy, order parameter, and other variables of interest were computed as a function of the applied magnetic field while the latter was varied continuously. (auth)

37416 INVESTIGATION OF THE DYNAMIC INTERMEDIATE STATE OF SUPERCONDUCTORS. Sharvin, Yu. V.; Landau, I. L. (Inst. of Physical Problems, Moscow). Zh. Eksp. Teor. Fiz.; 58: 1943-54(Jun 1970). (In Russian).

The motion of domains of the normal and superconducting phases under the action of a direct current (dynamic intermediate state) discovered previously is studied in single-crystal indium samples by observing oscillations of the resistance of thin wires in contact with the sample surface. It is found that moving lamellar structures possess a spatial period close to that of the static structures. Layers oriented by an external field can move at various angles with respect to the current direction. The measured value of the velocity satisfactorily agrees with the predictions of the theory. Layers parallel to the current are displaced with a velocity proportional to the resistance of the normal phase and inversely proportional to H_c. At temperatures remote from T_c, the velocity of layers perpendicular to the current is proportional to the Hall constant and close to the drift velocity of the charge carriers in the normal phase. (auth)

37417 MAGNETIC FLUX QUANTIZATION IN THE NORMAL STATE. Kulik, I. O. (Physical-Technical Inst., Kharkov). Zh. Eksp. Teor. Fiz.; 58 : 2171-5(Jun 1970). (In Russian).

The possibility is considered of quantum coherent effects appearing in superconductors at temperatures exceeding the critical superconducting transition temperature T_c. It is shown that in a superconducting ring located in a stationary magnetic field H and possessing a temperature $T > T_c$ a circulating current is induced which periodically varies as a function of the magnetic flux Φ. The current amplitude is proportional to the small parameter $e^{-L/\xi}$, where L is the ring circumference and $\xi(T) \sim v_0/\sqrt{T_c(T - T_c)}$ is the temperature-dependent coherence length. (auth)

37418 TUNNELING INTO A SUPERCONDUCTING RHENIUM SINGLE CRYSTAL. Ochiai, S. I.; MacVicar, M. L. A.; Rose, R. M. (Massachusetts Inst. of Tech., Cambridge). Solid State Commun.; 8: 1031-2(1 Jul 1970).

Tunneling measurements were made of $2\Delta(T)/k_B T_c$ for a superconducting rhenium single crystal over the range $0.89 \geq t \geq 0.58$. Within experimental error, the results follow a BCS curve, with $2\Delta(0)/k_B T_c = 3.38$. (auth) (UK)

37419 DETECTION OF VORTEX MOTION IN SUPERCONDUCTING SAMPLES BY MEANS OF A JOSEPHSON JUNCTION. Baixeras, J. (Faculte des Sciences, Paris); Pech, T. Solid State Commun.; 8: 1055-8(1 Jul 1970).

An original method is presented which allows one to study the vortex dynamics at one particular point of a superconducting sample. The vortex motion is detected by means of a point contact Josephson junction placed in the point under consideration, the critical dc Josephson current of the junction being modulated by the passage of vortices. The results of two types of experiments are in reasonably good agreement with theoretical predictions. (auth) (UK)

37420 SUPERCONDUCTIVITY AND PHONON SPECTRA OF DISORDERED THIN FILMS. Knorr, K.; Barth, N. (Univ., Frankfurt am Main). Solid State Commun.; 8: 1085-8(1 Jul 1970).

Disordered and recrystallized superconducting thin films of Pb, Sn and Bi are investigated by tunneling measurements. The coupling parameter times phonon density of states $\alpha(\omega)^2 F(\omega)$, the weighted phonon moments $\langle\omega\rangle$ and $\langle\omega^2\rangle$, the coupling constant λ and the Coulomb pseudo-potential μ^* are determined from the tunneling conductances. The disordered films always show strongly increased slopes of the phonon density of states at small energies and significant enhancements of λ. The calculated shifts of T_c are in agreement with the experiments. (auth) (UK)

37421 DYNAMICS OF A RECTILINEAR VORTEX IN LIQUID HELIUM II. Hall, H. E. (Univ. of Manchester, Eng.). J. Phys., C (London); 3: 1166-79(May 1970).

Steady flow in the neighborhood of a vortex line in liquid helium II is examined on the basis of Landau's equations of motion and directly from momentum considerations. It is shown that, in agreement with previous work, the mutual friction in rotating helium is transmitted to the superfluid via the Magnus effect. There is an additional force, of the form predicted by Iordanskii, which, contrary to previous work, is found to act on the normal fluid only. It is therefore predicted that the Iordanskii force will produce coupling of first sound to second sound in rotating helium II; if there is normal–superfluid conversion at the vortex core, this will also contribute to the coupling. The asymmetrical nature of the Iordanskii force also imposes certain constraints on the collision diameters of a vortex as requirements for the stability of the motion; these are briefly discussed. (auth) (UK)

37422 MUTUAL FRICTION MEASUREMENTS IN UNIFORMLY ROTATING LIQUID HELIUM. Lucas, P. (Univ. of Manchester, Eng.). J. Phys., C (London); 3: 1180-92(May 1970).

The mutual friction parameters B_{exp} and B'_{exp} defined by Hall were measured under the same experimental conditions over the temperature range from 1.4°K to within a few mdegK of the λ point, the parameter B'_{exp} to greater precision than previous measurements. In general the data agree with those of previous authors except those of Lipa et al. on B_{exp} near the λ point. The data have been used to calculate values of the parameters γ and γ' using Hall's model for the scattering of rotons by vortex lines. In the temperature range where comparison is meaningful the value of γ is an order of magnitude larger than Lifshitz and Pitaevskii's theoretical estimate, but order of magnitude agreement is obtained on the parameter γ'. (auth) (UK)

37423 FLUX FLOW RESISTIVITY BY SURFACE RESISTANCE MEASUREMENTS. Gilchrist, J. le G.; Monceau, P. (CNRS, Grenoble, France). J. Phys., C (London: 3: 1399-1409 (Jun 1970).

The surface resistance of three lead–indium alloys (50%, 10%, 3% indium) and two niobium–tantalum alloys (10%, 0.8% tantalum) was measured by a resonance method at 2.4 GHz as a function of applied field and temperature in the perpendicular arrangement (applied field perpendicular to the specimen surface). Comparison with results obtained earlier at 20 to 25 MHz shows that the surface resistance in the superconducting mixed state, at given field and temperature, divided by the normal state surface resistance, is independent of frequency. The results are interpreted macroscopically in terms of flux flow resistivity and found to agree with the differential resistivities measured directly on other pieces of the same samples, where such measurements were possible. Results are also presented for the alloys with low Ginzburg–Landau κ parameter and for temperatures not far below the critical temperature, where the resistivity could not be measured directly. The second Ginzburg–Landau parameter is extracted from the surface resistance data of the lead–indium alloys by use of a theoretical result of Maki et al., and is seen to agree with data obtained by magnetization measurements of the same specimens. (auth) (UK)

Plasma and Thermonuclear Physics

Refer also to abstract 38482.

37424 REVIEWS OF PLASMA PHYSICS. VOLUME 5. Leontovich, M. A. (ed.). New York; Plenum Publishing Corporation (1970). 537p. $25.00.

Translation of Voprosy Teorii Plazmy by Herbert Lashinskii. Separate abstracts were prepared for the 5 included sections. (M.O.W.)

For abstracts of individual sections see: 37429, 37445, 37485, 37486, and 37496.

Confinement and Heating

37425 (CTO–721) PLASMA DIFFUSION PARADOX IN TOROIDAL MAGNETIC TRAPS. Sagdeev, R. Z.; Galeev, A. A. Translated by L. C. Ronson (Culham Lab., Abingdon, Eng.), from Dokl. Akad. Nauk SSSR; 189: 1204-7(1969). 7p. Dep. CFSTI (U. S. Sales Only).

An abstract of this paper, prepared from the original language, appeared as NSA 24: 21761. (M.O.W.)

37426 (KHFTI–70-2) DYNAMICS OF PLASMA CURRENT IN THE FIELD OF PULSED MAGNETIC BARRIER. Zavada, P. I.; Kalmykov, A. A.; Tereshin, V. I.; Chebotarev, V. V. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). 1970. 23p. (In Russian). Dep. CFSTI (U. S. Sales Only).

The basic processes taking place in plasma in the vicinity of the magnetic barrier with a high energy field (15 to 20 kOe in center of the coil) were studied by experimental and theoretical means. The results were correlated within the limits of the generalized model of a current loop. The analysis revealed two processes in the field of the magnetic barrier: the reflection of a part of plasma current layers. (R.V.J.)

37427 (LA–4382-TR) COLLECTIVE INTERACTIONS AND PLASMA HEATING IN A HIGH-CURRENT GAS DISCHARGE. Suprunenko, V. A.; Sukhomlin, E. A.; Tolok, V. T. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). Translated by Helen J. Dahlby (Los Alamos Scientific Lab., N. Mex.), from report KHFTI–69-30. 8p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 24: 15296. (M.O.W.)

37428 (ORNL–TM–3076) NEUTRAL BEAM ION HEATING IN ORMAK II. Kelley, G. G.; Morgan, O. B.; Postma, H. (Oak Ridge National Lab., Tenn.); Forsen, H. K. (Wisconsin Univ., Madison). Jul 1970. Contract W-7405-eng-26. 18p. Dep. CFSTI.

Ion and electron temperatures of several keV should be obtained from a system of 4 injectors in ORMAK II. Calculations of the expected performance of the system are described. (auth)

37429 PLASMA CONFINEMENT IN CLOSED MAGNETIC SYSTEMS. Solov'ev, L. S.; Shafranov, V. D. pp 1-247 of Reviews of Plasma Physics. Vol. 5. /Leontovich, M. A. (ed.). New York; Plenum Publishing Corporation (1970).

A theoretical review of closed magnetic systems is presented. The following sections are described: (1) general properties of toroidal configurations, (2) orthogonal coordinate system with spatial axis, (3) magnetic field near a given line of force, (4) structure of magnetic surfaces in the vicinity of a closed line of force, (5) magnetic surfaces close to a magnetic axis, (6) shape of toroidal magnetic surfaces, (7) perturbation of magnetic surfaces by a first harmonic field, (8) solution of the equations for the parameters of the magnetic surface, (9) perturbation of toroidal magnetic surfaces, (10) plasma equilibrium in a toroidal system, (11) effect of curvature on classical diffusion and thermal conductivity, (12) integral characteristics of toroidal magnetic configurations, (13) examples of actual systems, (14) helical magnetic configurations, and (15) containment of charged particles in closed toroidal configurations. (M.O.W.)

37430 PINCH EFFECT FOR TRAPPED PARTICLES IN A TOKAMAK. Ware, A. A. (Univ. of Texas, Austin). Phys. Rev. Lett.; 25: 15-17(6 Jul 1970).

Conservation of canonical angular momentum is shown to require that all trapped particles drift towards the magnetic axis with velocity cE_φ/B_Θ (E_φ is the toroidal electric field; B_Θ the poloidal magnetic field). This property, plus an amplification process for the number of trapped particles, will explain the relaxation oscillations that occur for $q < 3$. In addition, there is experimental evidence that it is an important contribution to the good containment when $q > 3$. (auth)

37431 METHOD FOR CONFINEMENT OF ELECTRONS IN CLOSED SYSTEMS. Peregud, B. P. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Tech. Phys. (Engl. Transl.); 14: 572-4(Oct 1969).

Translated from Zh. Tekh. Fiz.; 39: 760-4(Apr 1969).

A method is proposed for electron injection into the system by means of an injector located inside the system or gradually introduced into it. In the stationary mode of system operation measurements are made of the currents in all the structural elements including the current to the injector itself, to its support, and the current to the 4π collector surrounding the system. The amount of space charge built up in the system is also measured. (M.O.W.)

37432 MODEL FOR THE STOCHASTIC HEATING OF ELECTRONS. Polovin, R. V.; Rozhkov, V. V. (Physical-Technical Inst., Kharkov). Sov. Phys.-Tech. Phys. (Engl. Transl.); 14: 1026-9(Feb 1970).

Translated from Zh. Tekh. Fiz.; 39: 1360-4(Aug 1969).

A model is proposed for the stochastic heating of electrons located in a constant, homogeneous magnetic field, under the influence of a spatially uniform stochastic electric field. The friction of the electrons is taken into account. The electric field is considered to be a stationary Gaussian Markov process. It is shown that the electron energy as well as the correlations of the velocity and electric field components go to finite limiting values. These values and the relaxation time are found. The problem is solved using stochastic differential equations by adding a process to the Markov process and by solving the Fokker–Planck equation for a distribution function which depends not only on the random velocity, but also on the random electric field. (auth)

Diagnostics

Refer also to abstracts 37220, 37352, 37353, and 37455.

37433 (ORO–3819-2) EXPERIMENTAL STUDY OF STREAMING LASER-PRODUCED PLASMAS. Progress Report, April 1, 1969–May 30, 1970. Koopman, David W. (Maryland Univ., College Park. Inst. for Fluid Dynamics and Applied Mathematics). Jun 1970. Contract AT(40-1)-3819. 114p. (BN–658). Dep. CFSTI.

The progress made in a research program to investigate plasma phenomena in streaming, laser-produced plasmas is reviewed. Particular attention is given to the development of two diagnostic techniques appropriate to the experimental studies being performed. Langmuir probes have been built and tested; theoretical studies bearing on their suitability for use in flowing plasmas are also described. As a complementary technique, Lecher-wire microwave interferometers in configurations useful for measuring electron density in flowing plasmas have been developed. Satisfactory agreement between probes and microwave measurements has been obtained. Using the experimental apparatus, the conditions in laser-produced plasmas streaming in a vacuum 18 to 50 cm from the point at which the laser is focused on a solid target have been measured. Flow velocity, electron density, electron temperature, probe characteristics, and transverse ion flux have been obtained. The effect of a background gas in the vacuum chamber has been examined. Ionization by independent ionization devices, by photoemission from the initial dense laser plasma, and by charge exchange from streaming ions has been observed. Anomalous ion heating at the interpenetration region between the streaming plasmas and the ionized background has not been observed. Comparisons to theoretical treatments of counter-streaming instabilities and collisionless electrostatic shocks are described. A limited

amount of data on phenomena associated with magnetic fields superimposed on the counterstreaming plasmas has been obtained. (auth)

37434 (SIT-2582-33) PROJECT CHALICE. SOME CONTRIBUTIONS TO PLASMA DIAGNOSTICS. Special Report No. 2 on Plasma Physics. (Stevens Inst. of Tech., Hoboken, N. J. Dept. of Physics). 1 Jun 1970. Contract AT(30-1)-2582. 51p. (SIT-252). Dep. CFSTI.

Separate abstracts are presented for 3 individual sections. (M.O.W.)

For abstracts of individual sections see: 37435–37437.

37435 (SIT-2582-33, pp 1-13) ANALYSIS OF PLASMAS WITH TWO WAVELENGTHS OF INCIDENT RADIATION. Percus, Jerome K.; Yevick, George J. (Stevens Inst. of Tech., Hoboken, N. J. Dept. of Physics).

From Project Chalice. Some contributions to plasma diagnostics.

Design and analysis of very hot plasmas is beset by many difficulties, not the least of which is the difficulty of diagnostics. A fairly effective approach to measuring density and velocity profiles is by means of Thomson scattering of electromagnetic radiation by the mobile electrons. Standard methods use nearly monochromatic and nearly unidirectional radiation. Rather than accept some irreducible spread in frequency and angle, the effect of controlling the distributions of both frequency and direction is investigated. It develops that a much finer analysis of the plasma density in phase space can be obtained in this way. (auth)

37436 (SIT-2582-33, pp 14-42) OPTICAL INTERFEROMETRY. Harvey, Robin J. (Stevens Inst. of Tech., Hoboken, N. J. Dept. of Physics).

From Project Chalice. Some contributions to plasma diagnostics.

A method for increasing the fringe-shift resolution of a two-dimensional optical interferogram by more than an order of magnitude without loss of a spatial resolution is described. A Fabry–Perot cavity is used as an interferometer to increase the number of passes. The "sharpened" fringes are multiplied in number by using a multimode laser as a light source. The fringe pattern (observed without a lens) is equivalent to that of a Mach–Zehnder interferometer except that a shift of one fringe corresponds to an optical path length difference of $\lambda/2\alpha$ (instead of λ), when the cavity lengths are in the ratio $L/L_q = 1/\alpha$ and α is the number of excited laser modes. (auth)

37437 (SIT-2582-33, pp 43-51) SOME PRACTICAL CONSIDERATIONS FOR THE MEASUREMENT OF PLASMA ELECTRON TEMPERATURE BY THOMSON SCATTERING. Carr, Wayne (Stevens Inst. of Tech., Hoboken, N. J. Dept. of Physics).

From Project Chalice. Some contributions to plasma diagnostics.

Problems arising with the use of Thomson scattering for plasma diagnostics are discussed. Calculations and comments to help resolve these problems are given. (M.O.W.)

37438 SIMULTANEOUS MEASUREMENT OF ELECTRON DENSITIES AND OF TEMPERATURES IN THE PLASMA ACCOMPANIED BY MOVING STRIATIONS. Hamamura, Shiro (Hiroshima Univ.); Otagaki, Hiroshi. Jap. J. Appl. Phys.; 9: 118(Jun 1970).

Fluctuations in electron density and temperature of an Ar plasma were measured simultaneously by means of a microwave cavity resonating at 9450 MHz in the TM_{010} mode. Measured curves are presented for $\nu_c(t)$ (collision frequency), $\Delta(1/Q_a(t))$, $\Delta f(t)$, and light intensity. (D.L.C.)

37439 APPLICATION OF THE SKIN EFFECT TO THE DETERMINATION OF ELECTRON DENSITY IN MICROWAVE-EXCITED PULSE DISCHARGES. Macau-Hercot, D. (Univ., Liege). Bull. Soc. Roy. Sci. Liege; 38: 700-7(1969). (In French).

The application of the skin effect to pulsed discharges excited by microwaves is used as a new means for determination of plasma electron density. This method is, unfortunately, valid only during the deposition of energy; it presents, nevertheless, nonnegligible advantages of not having to employ absolute measurements, always delicate to carry out, and is also applicable even if the plasma is not in equilibrium. (tr-auth)

37440 INVESTIGATION OF PLASMA COMPRESSION USING MICROWAVE REFLECTION. Ipatov, V. A.; Kaganskii, M. G.; Kalmykov, S. G.; Ovsyannikov, V. A. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Tech. Phys. (Engl. Transl.); 14: 479-83(Oct 1969).

Translated from Zh. Tekh. Fiz.; 39: 638-43(Apr 1969).

It is shown that the compression of a plasma by an external magnetic field can be investigated using microwave location. The measurements were carried out at wavelengths of 4 and 8 mm. It is shown that in the Tuman device a sharp decrease of the plasma density occurs near the limiter in compression. The radius, within which the density exceeds 1.7×10^{13} cm^{-3}, decreases to 3 cm in compression (radius of the limiter is 6 cm). The rate of displacement of plasma layers with density 1.7×10^{13} and 7×10^{13} cm^{-3} was measured during the expansion of the plasma that occurs with decay of the magnetic compression field. It was found that the rate of expansion of the plasma layers with this density is 2 to 3 times larger than the rate computed, assuming the magnetic field to be frozen in the plasma. (auth)

37441 LABORATORY STUDY OF PROBE IMPEDANCE. Heikkila, W. J. (Southwest Center for Advanced Studies, Dallas). pp 231-46 of Plasma Waves in Space and in the Laboratory. Vol. I. /Thomas, J. O. (ed.). New York; American Elsevier Publishing Co., Inc. (1969).

From Conference on Plasma Waves in Space and in the Laboratory, Roeros, Norway. See CONF-680455-(Vol.1).

An experimental technique for studying the probe impedance in a laboratory plasma is described. The experimental results are reviewed. (M.O.W.)

37442 THEORY OF A CYLINDRICAL PROBE. Savchenko, O. Ya. (Inst. of Nuclear Physics, Novosibirsk, USSR). Sov. Phys.-Tech. Phys. (Engl. Transl.); 14: 1187-9(Mar 1970).

Translated from Zh. Tekh. Fiz.; 39: 1582-5(Sep 1969).

The voltage–current characteristic is presented for a cylindrical probe in a collisionless plasma whose particles have a Maxwellian velocity distribution. Conditions are noted for which actual probe characteristics correspond with the theory. Experimentally determined cylindrical probe characteristics in a hydrogen arc (positive probe potential) agree with the computed characteristic. However, the actual ion currents at large negative potential are significantly smaller than theoretical ion currents. It is proposed that this experimental result is due to the presence of significant electron orbital motion and the absence (due to charge exchange) of ion orbital motion. (auth)

Kinetics (General)

Refer also to abstract 37178.

37443 TRANSMISSION AND EMISSION OF RADIATION BY A MAGNETIZED LABORATORY PLASMA. Dreicer, H. pp 157-94 of Plasma Waves in Space and in the Laboratory. Vol. I. /Thomas, J. O. (ed.). New York; American Elsevier Publishing Co., Inc. (1969).

From Conference on Plasma Waves in Space and in the Laboratory, Roeros, Norway. See CONF-680455-(Vol.1).

Radiations from a magnetized plasma at harmonics of the cyclotron frequency are discussed. An experimental study was made to determine the transition between single-particle behavior and plasma behavior. It is concluded that the onset of copious harmonic emission coincides with the onset of poor transmission conditions for microwaves propagating through the plasma. (M.O.W.)

37444 LABORATORY MEASUREMENTS OF THE IMPEDANCE AND RADIATION PATTERN OF ANTENNAS IN AN ISOTROPIC PLASMA. Jassby, D. L. (Univ. of Princeton, N. J.); Bachynski, M. P. pp 285-302 of Plasma Waves in Space and in the Laboratory. Vol. I. /Thomas, J. O. (ed.). New York; American Elsevier Publishing Co., Inc. (1969).

From Conference on Plasma Waves in Space and in the Laboratory, Roeros, Norway. See CONF-680455-(Vol.1).

Theoretical considerations for investigating the behavior of antennas in plasmas are discussed. The plasma facility and measuring techniques are described. Measurements of the impedance of a quarter wave monopole and the radiation from a half-wave dipole are described also. (M.O.W.)

37445 MAGNETOHYDRODYNAMIC THEORY OF THE PINCH EFFECT IN A DENSE HIGH-TEMPERATURE PLASMA (DENSE PLASMA FOCUS). D'yachenko, V. F.; Imshennik, V. S. pp 447-95 of Reviews of Plasma Physics. Vol. 5. /Leontovich, M. A. (ed.). New York; Plenum Publishing Corporation (1970).

The one-dimensional cylindrically symmetric nonstationary problem is solved. The entire analysis is carried out within the framework of magnetohydrodynamics, taking account of dissipation effects such as the electron thermal conductivity, the ion thermal conductivity, the ion viscosity, the electric conductivity, and the exchange of energy between electrons and ions by virtue of collisions. The dissipation coefficients are determined for a fully ionized plasma; effects due to neutral particles are not considered. (M.O.W.)

Kinetics (Experimental)

37446 ION OSCILLATIONS IN HOLLOW CATHODES IN A MAGNETIC FIELD. Ionescu, Theodore V.; Parvan, Radu; Baianu, Ion (Univ. of Bucharest). Compt. Rend., Ser. B; 270: 1321-4(25 May 1970). (In French).

It is shown that very intense vibrations can take place in plane anode and cylindrical hollow cathode tubes if a magnetic field, parallel to or inclined on the axis of the cathode is applied to them. These oscillations are described and the nature of some of them was determined. (France)

37447 DEPOLARIZATION OF A PLASMA STREAM IN CONSTANT AND VARIABLE TRANSVERSE MAGNETIC FIELDS. Gol'ts, E. Ya.; Khodzhaev, A. Z. (Lebedev Inst. of Physics, Moscow). Sov. Phys.-Tech. Phys. (Engl. Transl.); 14: 741-4 (Dec 1969).

Translated from Zh. Tekh. Fiz.; 39: 988-92(Jun 1969).

A study is reported of the motion of a plasma stream in constant and rapidly growing transverse magnetic fields. The resulting polarization field is found to have a substantial effect on the behavior of the plasma. Thin stainless-steel plates located at right angles to the magnetic field are found to reduce the polarization field by a substantial factor. This means that a proportion of the plasma stream can be cut off so that plasmoids can be produced. For plasma stream densities of 10^{14} cm^{-3} and magnetic fields of 3.1 kG, the density drop at the rear of a plasmoid is 300 to 500, and the length of the trailing edge is equal to the rise time of the magnetic field (~0.15 μsec). (auth)

37448 PRECURSOR IONIZATION IN FRONT OF A MOVING PLASMOID. Malkin, O. A.; Musin, A. K. Sov. Phys.-Tech. Phys. (Engl. Transl.); 14: 821-7(Dec 1969).

Translated from Zh. Tekh. Fiz.; 39: 1092-1100(Jun 1969).

Results are given of measurements of charged-particle density in the ionized cloud that precedes a basic plasmoid and is formed by the radiation from the moving plasma formation. The spatial distribution of the electron density in the ionized cloud ahead of the plasmoid is obtained. (auth)

37449 TWO-STEP DEVELOPMENT OF A CURRENT PULSE BETWEEN PLANE ELECTRODES. Malkin, O. A.; Trekhov, E. S. (Inst. of Physics, Moscow). Sov. Phys.-Tech. Phys. (Engl. Transl.); 14: 816-20(Dec 1969).

Translated from Zh. Tekh. Fiz.; 39: 1086-91(Jun 1969).

The development of a current pulse near a fixed ignition site was studied. The existence of a current layer moving in the region with high magnetic pressure and accompanied by a radiation front was found with the aid of a streak camera. This phenomenon may explain the diffusion of charged particles across the magnetic field of the current path. The current pulse is shown to develop in two steps under the experimental conditions. (auth)

37450 LONGITUDINAL POTENTIAL GRADIENT IN A POSITIVE COLUMN IN H_2 AND D_2. Breusova, L. N. Sov. Phys.-Tech. Phys. (Engl. Transl.); 14: 862-3(Dec 1969).

Translated from Zh. Tekh. Fiz.; 39: 1143-5(Jun 1969).

The ratio of the potential gradients of H_2 and D_2 was found by measuring the operating voltage of the discharge in a tube with a varying column length. The measurements were made with a stationary discharge for currents beginning from 0.003 up to 1A, and for a discharge fed by rectangular pulses of current of duration 30 μsec with a current strength up to several kiloamperes for a pulse repetition frequency of 20 pulses/sec. (M.O.W.)

37451 AFTERGLOW DIFFUSION IN VARIOUS GASES. Bulanin, V. V.; Zhilinskii, A. P.; Smirnov, V. I. (Leningrad Polytechnical Inst.). Sov. Phys.-Tech. Phys. (Engl. Transl.); 14: 464-71(Oct 1969).

Translated from Zh. Tekh. Fiz.; 39: 617-27(Apr 1969).

Results of measurements performed in a uniform magnetic field on the diffusional decay of plasmas in helium, argon, hydrogen, cesium, and mercury are presented and compared. It is shown that the anomalous diffusion across the magnetic field that is observed under certain conditions is essentially independent of the gas and the neutral pressure. (auth)

37452 BREMSSTRAHLUNG RADIATION FROM WEAKLY IONIZED LABORATORY PLASMA. Prasad, R. Y.; Mishra, K. D.; Singh, R. N. (Banaras Hindu Univ., India). Int. J. Electron.; 29: 65-71(Jul 1970).

The binary collisions between electrons and atoms are considered as a source of electromagnetic wave emission. The dispersive effect of the ambient plasma on the absorption and emission of electromagnetic waves is studied. The Boltzmann transport equation with the collision term is linearized and solved for the transverse dielectric constant of the ambient plasma. The absorption and emission coefficients are evaluated for the laboratory plasma. The total electromagnetic wave power in the frequency $\omega_p < \omega < 10\omega_p$ is calculated. The effect of the first- and second-order approximations in the collision term on the emission and absorption characteristics is studied. (auth) (UK)

37453 INVESTIGATION OF PHYSICAL PROCESSES IN AN ELECTRODE-DISCHARGE SHOCK TUBE. Grechikhin, L. I.; Davydov, B. B.; Min'ko, L. Ya. (Inst. of Physics, Minsk). Sov. Phys.-Tech. Phys. (Engl. Transl.); 14: 518-21(Oct 1969).

Translated from Zh. Tekh. Fiz.; 39: 689-93(Apr 1969).

The structure of the plasma stream inside the discharge device of a shock tube is investigated. It is shown that the physical processes occurring in an electrode-discharge tube depend on the nature of the discharge (surface or nonsurface). It is established that a supersonic plasma jet flows out from the central electrode (nonsurface discharge) with no further growth. It is suggested that the formation of the shock wave begins before the exit from the discharge device. (auth)

37454 EMISSION OF ENERGETIC IONS FROM A PENNING DISCHARGE IN AN INHOMOGENEOUS MAGNETIC FIELD. Demirkhanov, R. A.; Kursanov, Yu. V.; Skripal, L. P. Sov. Phys.-Tech. Phys. (Engl. Transl.); 14: 500-1(Oct 1969).

Translated from Zh. Tech. Fiz.; 39: 666-8(Apr 1969).

The energy distributions of the ions and electrons were measured in a plasma jet from an ion source in a Penning discharge. Also measured were the axial potential distribution and the intensity of the ion flux. It is shown that the polarization electric field in which the ions are accelerated is localized in the region of an inhomogeneous magnetic field. (auth)

37455 ELECTRON ENERGY DISTRIBUTION IN A HIGH-FREQUENCY DISCHARGE. Vagner, S. D.; Virolainen, V. A.; Kagan, Yu. M. (Karelian Pedagogical Inst., Petrozavodsk, USSR). Sov. Phys.-Tech. Phys. (Engl. Transl.); 14: 502-4(Oct 1969).

Translated from Zh. Tekh. Fiz.; 39: 669-72(Apr 1969).

A circuit for measuring the electron distribution in a hf discharge is described. The operation of the circuit and some experimental results are discussed. (M.O.W.)

37456 SIMPLE TECHNIQUE FOR SINGLE SHOT, MICROWAVE SPECTRUM ANALYSIS. Nation, John A. (Cornell Univ., Ithaca, N. Y.). Rev. Sci. Instrum.; 41: 1097-8(Jul 1970).

Typical radiation pulses from plasmas with durations of 15 to 50 nsec were studied. The spectra were essentially restricted to frequencies in the x band. The radiation pulse was fed through a long guide, and the output from a broad band detector was fed directly to an oscilloscope. The output pulse was time-correlated with a signal indicating the onset of the radiation pulse. The technique and an experiment are described. (M.O.W.)

37457 CYCLOTRON INTERACTION BETWEEN AN ELECTRON BEAM AND THE FAST MAGNETOSONIC WAVE. Ermakov, A. I.; Nazarov, N. I. Sov. Phys.-Tech. Phys. (Engl. Transl.); 14: 1180-3(Mar 1970).

Translated from Zh. Tekh. Fiz.; 39: 1573-7(Sep 1969).

The interaction between an electron beam and high-frequency plasma oscillations was investigated experimentally in a range of frequencies much lower than the electron gyrofrequency and higher than the ion gyrofrequency ($\omega_{He} \gg \omega > \omega_{Hi}$). It is shown that an efficient interaction between the electron beam and plasma oscillations occurs if the anomalous Doppler effect conditions are satisfied ($\omega - kv_0 + \omega_{He} = 0$). The energy exchange between the beam particles and the oscillations alters the beam energy considerably. (auth)

37458 EFFECT OF LOW-FREQUENCY OSCILLATIONS ON THE CYCLOTRON RADIATION OF A PLASMA COLUMN. Kuznetsov, Yu. K.; Pavlichenko, O. S.; Starikov, V. N. (Physical-Technical Inst., Kharkov). Sov. Phys.-Tech. Phys. (Engl. Transl.); 14: 1184-6(Mar 1970).

Translated from Zh. Tekh. Fiz.; 39: 1578-81(Sep 1969).

An experimental investigation was made of the effect of low-frequency oscillations in a plasma, both characteristic ones and those excited by means of an external generator ($f \approx 2$ MHz), on different types of cyclotron radiation ($f \approx 10$ GHz) of a reflection discharge. (auth)

Kinetics (Theoretical)

Refer also to abstract 37583.

37459 (AD-686856) QUASI-PARTICLE DESCRIPTIONS IN CLASSICAL MANY PARTICLE SYSTEMS. Marcuvitz, N. (New York Univ., N. Y. Dept. of Electrical Engineering). Apr 1969. Contract Nonr-285(66). 21p. CFSTI.

Quasi-particle descriptions of thermal or weakly turbulent

fluctuations in classical many-particle systems may be based on a complete set of eigenmodes which, for a Maxwellian–Vlasov electron plasma, comprise a set of continuous and discrete modes, both longitudinal and transverse. The continuum modes are dressed single-particle excitations with real eigenvalues; they can be expressed alternatively in terms of discrete quasi modes corresponding to complex quasi eigenvalues on the unphysical sheet of the complex energy (frequency) plane. For weakly correlated fluctuations such quasi-mode representations can be interpreted in terms of quasi-particles moving in their phase space along trajectories determined by dispersion (energy) relations characteristic of the quasi modes; the quasi-particle density in phase space is determined by the amplitude correlation spectrum of the quasi modes. The specifics of this quasi-particle viewpoint are discussed for the case of an electron plasma. (auth) (USGRDR)

37460 (IPPJ–90) THEORY OF ELECTRON IMPACT BROADENING IN PLASMA. Tsuji, Akio; Narumi, Hajime (Nagoya Univ. (Japan). Inst. of Plasma Physics). Apr 1970. 18p. Dep. CFSTI (U. S. Sales Only).

A quantum-mechanically consistent formulation of the theory of electron-impact broadening in plasmas is given by using the scattering matrices obtained from a closed-coupling procedure instead of the classical path approximation, where the parameter of the impact radius, can be removed. Specific calculations of neutral and ionized radiators are carried out for hydrogenic systems. (NSA of Japan)

37461 (ITF–70–11) MODIFIED WKB METHOD. [PART] I. Mentkovskii, Yu. L. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1970. 14p. Dep. CFSTI (U. S. Sales Only).

A new method of derivation of absolutely convergent modified WKB–expansions is suggested. The method is free of matrix calculations. (auth)

37462 NONEQUILIBRIUM IN CONFINED-ARC PLASMAS. Kruger, Charles H. (Stanford Univ., Calif.). Phys. Fluids; 13: 1737-9(Jul 1970).

The nonequilibrium behavior of argon and helium confined-arc plasmas at atmospheric pressure is analyzed in terms of a two-temperature ambipolar-diffusion model. Examination of spectroscopic data for the nonequilibrium arc shows that the free and bound electrons are mutually in equilibrium at a common electron temperature but not in equilibrium with the translational degrees of freedom of the heavy particles; the electron density in the outer portions of the arc may be as much as several orders of magnitude greater than its local thermodynamic-equilibrium value. Integration of the electron continuity equation and the electron and heavy-particle energy equations, with calculated transport properties and recombination coefficients, yields a satisfactory comparison with the measurements. (auth)

37463 ELECTRODYNAMIC PLASMA ACCELERATION IN HIGH-CURRENT PULSED ACCELERATORS. Kolesnikov, P. M.; Azarevich, A. Ya.; Vyatkin, G. I.; Zorik, V. Ya.; Kashpruk, V. F.; Shevchenko, V. V. Sov. Phys.-Tech. Phys. (Engl. Transl.); 14: 622-6(Nov 1969).

Translated from Zh. Tekh. Fiz.; 39: 829-36(May 1969).

The effect of drag on the motion of plasma in high-current pulsed plasma accelerators is investigated. The accelerators considered are the "rail" and Marshall types. A number of methods are used to compare the relative effects of drag by undisturbed gas (proportional to the square of the plasma velocity) and the friction force (proportional to the plasma velocity or to the product of the velocity and the total current flowing in the circuit) in comparison with the ideal case with no drag force. Figures are presented giving all basic characteristics of the pulsed acceleration: the variation of the current, voltage, velocity, distance with respect to time, efficiency, and specific momentum. On the basis of experimental data on the erosion of the electrodes, a theoretical investigation is made of the effect of electrode erosion on the basic parameters of pulsed acceleration. The results of this calculation are compared with earlier investigations. (auth)

37464 DISTRIBUTION FUNCTION OF AN ELECTRON BEAM IN A BEAM–PLASMA DISCHARGE. Shustin, E. G.; Popovich, V. P.; Kharchenko, I. F. (Inst. of Radio Tech. and Electronics, Moscow). Sov. Phys.-Tech. Phys. (Engl. Transl.); 14: 745-50 (Dec 1969).

Translated from Zh. Tekh. Fiz.; 39: 993-1000(Jun 1969).

The distribution function of an electron beam was studied in the presence of high-frequency oscillations in the plasma created by the beam. The total power lost by the beam was determined, and a correlation was found between the shape of the distribution function and the amplitude of the high-frequency oscillations for various system parameters. A numerical comparison of the energy loss and the beam relaxation time with theoretical values was made. The system has been found to go into a state in which energy is transferred to the low-frequency part of the spectrum in which case the distribution function exhibits a negative derivative; this supports the quasi-linear theory for beam-drift instability in systems with radially limited electron beams. (auth)

37465 ELECTRODE SPACE-CHARGE SHEATH IN A PLASMA MOVING IN A MAGNETIC FIELD. Musin, A. K. Sov. Phys.-Tech. Phys. (Engl. Transl.); 14: 828-33(Dec 1969).

Translated from Zh. Tekh. Fiz.; 39: 1101-9(Jun 1969).

The effects of electrode space-charge sheaths on the electrical current in a plasma moving in a magnetic field are examined for both intense and weak electron emission from the cathode. The electron temperature in the electrode sheath and in the plasma region is also considered. (auth)

37466 NONLINEAR INTERACTION OF ELECTROSTATIC WAVES WITH ION–ION COLLISIONS IN A TURBULENT PLASMA. Makhan'kov, V. G.; Tsytovich, V. N. (Joint Inst. for Nuclear Research, Dubna, USSR). Sov. Phys.-Tech. Phys. (Engl. Transl.); 14: 594-601(Nov 1969).

Translated from Zh. Tekh. Fiz.; 39: 788-99(May 1969).

The effect of ion–ion collisions on the nonlinear interaction of electrostatic waves in a turbulent plasma is investigated. It is shown that there are broad regions of electron and ion temperatures and plasma densities where the nonlinear interaction of electrostatic waves is affected only by ion–ion collisions. It is also shown that the inclusion of ion–ion collisions can increase the intensity of the spectral transfer. Consequently, ion–ion collisions must be considered in estimating effects due to nonlinear interactions. (auth)

37467 RELAXATION OF ELECTRON AND ION TEMPERATURES IN A PLASMA IN A STRONG MAGNETIC FIELD. Silin, V. P.; Chernyi, G. P. (Lebedev Inst. of Physics, Moscow). Sov. Phys.-Tech. Phys. (Engl. Transl.); 14: 589-93(Nov 1969).

Translated from Zh. Tekh. Fiz.; 39: 781-7(May 1969).

The effective collision frequency of electrons and ions leading to the equalization of temperatures in the plasma is determined under conditions where the electron gyroradius is smaller than the Debye shielding distance. The maximum time for the particle interaction is determined by their acceleration due to Coulomb interactions along the magnetic field. The corresponding limitation on the interaction time is found from the collision integral. (auth)

37468 PLASMA TRANSPORT EQUATIONS. Kirii, A. Yu.; Silin, V. P. (Lebedev Inst. of Physics, Moscow). Sov. Phys.-Tech. Phys. (Engl. Transl.); 14: 583-8(Nov 1969).

Translated from Zh. Tekh. Fiz.; 39: 773-80(May 1969).

The Grad method is used to derive the hydrodynamic equations for a multicomponent plasma; these equations are convenient for the description of cases in which the mean relative velocities of the electrons and ions are not small in comparison with the mean electron velocity. (auth)

37469 TURBULENT SHOCK WAVES IN A COLLISION-FREE PLASMA. Viswanathan, K. S.; Dwarakanath, G. S. (National Aeronautical Lab., Bangalore, India). Proc. Indian Acad. Sci., Sect. A; 71: 119-40(Mar 1970).

The structure of collisionless shocks arising from turbulent wave–particle interactions was studied. The conditions under which wave–particle interaction effects could become significant leading to growing waves and a shock are discussed. Using the Mott–Smith expression for the zero-order distribution functions for the ions within the shock, the dielectric constant as well as the integral representing the wave–particle interaction term in the Lenard–Balescu equation are evaluated for a collisionless plasma. An expression is given for the ion distribution function within the shock. It is shown that the component of the pressure tensor perpendicular to the direction of flow of the plasma leads to a new kind of viscosity term arising from the interaction of the particles with the growing waves and this provides a dissipative mechanism to account for the conversion of the kinetic energy of the incoming plasma into the thermal energy of the hot ionized gas behind the shock. (auth)

37470 ANOMALOUS DIFFUSION IN A COLLISIONAL PLASMA IN A MAGNETIC FIELD. Fridman, A. M. (Novosibirsk State Univ., USSR). Sov. Phys.-Tech. Phys. (Engl. Transl.); 14: 484-5(Oct 1969).

Translated from Zh. Tekh. Fiz.; 39: 644-6(Apr 1969).

An instability with growth rate γk_z^2 (χ is the electron thermal conductivity and k_z is the wave vector along the magnetic field) is shown to occur in a strongly ionized collisional plasma in the

frequency range $\omega_{Bi} \ll \omega \ll \omega_{Be}$ (ω_{Bi} and ω_{Be} are the ion and electron cyclotron frequencies, respectively). This instability causes an anomalous diffusion across the magnetic field. The diffusion coefficient is $D = (R/r)D_{cl}$ (R and r are the longitudinal and transverse dimensions of the system, and D_{cl} is the classical diffusion coefficient). The conditions of the problem and the diffusion coefficient agree with the experimental data for particle diffusion in a gaseous discharge. (auth)

37471 POSSIBLE CHARGE SEPARATION IN A PLASMA BY RECOMBINATION RADIATION. Voronov, A. Ya. (Moscow Physical Engineering Inst.). Sov. Phys.-Tech. Phys. (Engl. Transl.); 14: 580-1(Oct 1969).
Translated from Zh. Tekh. Fiz.; 39: 770-2(Apr 1969).

Results are presented of an approximate solution to a system of diffusion equations written for the stationary case of spherical symmetry. The equations take into account the force on free electrons produced by the recombination radiation field of the plasma. An expression defining space charge density at the center of the plasma sphere is sought. Numerical evaluations made for nitrogen indicate that, when the ionization is strong, the magnitude of this charge can exceed by several orders of magnitude the usual value arising from the greater mobility of electrons over ions. (auth)

37472 COMPUTATIONAL STUDY OF THE CORRELATION FUNCTIONS OF A WEAK TURBULENT PLASMA. Makhan'kov, V. G.; Shchinov, B. G. (Joint Inst. for Nuclear Research, Dubna, USSR). Phys. Rev. Lett.; 25: 18-20(6 Jul 1970).

The nonlinear integral equation that describes correlation functions of a quasi-steady Langmuir turbulence is investigated by the use of a computer. The form and width of the Fourier component of the space–time correlation function was obtained for various values of the wave number. The correlation-curve width is determined (in the case in question) by four-plasmon interactions and can be significant even for a quite small turbulence level. The method developed permits one to determine the level of the turbulence energy by the width of the correlation curve. (auth)

37473 VELOCITY OF PLASMA INHOMOGENEITIES IN CROSSED ELECTRIC AND MAGNETIC FIELDS. Chekmarev, I. B.; Rozov, S. I.; Drobyshevskii, E. M. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Tech. Phys. (Engl. Transl.); 14: 496-9(Oct 1969).
Translated from Zh. Tekh. Fiz.; 39: 660-5(Apr 1969).

A theoretical study of the diffusion of plasma inhomogeneities in crossed magnetic and electric fields was carried out for the particular case of uniform motion of a periodic system of plasma sources between parallel nonconducting walls. On the assumption of quasineutrality and a low degree of ionization, a solution is discussed for arbitrary arrangement of plasma sources. An expression is obtained for plasma velocity for sources in the form of a delta function. (auth)

37474 DETAILED STRUCTURE OF BEAM–PLASMA INSTABILITY. Lavrovskii, V. A.; Deev, V. M.; Rogashkov, S. A.; Yaremenko, Yu. G.; Kharchenko,. F. Sov. Phys.-Tech. Phys. (Engl. Transl.); 14: 1190-5(Mar 1970).
Translated from Zh. Tekh. Fiz.; 39: 1586-93(Sep 1969).

The structure of rf oscillations excited in a beam plasma system in a longitudinal magnetic field is examined; transient and relaxation processes in the plasma are considered. In order to obtain the time and statistical characteristics of the process, an electronic computer is used. The instantaneous spectra, correlation functions, and probability distributions are determined; the time stationarity and the presence of possible periodicities in the oscillatory process are examined. (auth)

37475 ELECTRON ENERGY DISTRIBUTION IN THE ELECTRODE SHEATH IN A WEAKLY IONIZED PLASMA. Baksht, F. G. (Inst. of Semiconductors, Leningrad). Sov. Phys.-Tech. Phys. (Engl. Transl.); 14: 1196-1204(Mar 1970).
Translated from Zh. Tekh. Fiz.; 39: 1594-1606(Sep 1969).

The energy distribution function is considered for electrons injected into a plasma through an accelerating potential barrier near an electrode; the plasma is weakly ionized and the distribution function is made symmetric with respect to direction by scattering on neutrals before the character of the energy distribution is altered by collisions with the electrodes. The electron motion can be considered as diffusion in ordinary space and in energy space, and the problem becomes one with a second-order partial differential equation with boundary conditions of the third kind at the potential barrier, which take different forms for $E < E_0$ and $E > E_0$ (E is electron energy and E_0 is height of the potential barrier). This problem has been considered previously for the limiting cases of large and small electron reflection coefficients at the boundary of the plasma. Here the general case, which corresponds to intermediate values of the reflection coefficient, is considered; allowance is made for a possible density inhomogeneity in the plasma. (auth)

37476 FAST ELECTRON DISTRIBUTION AT A CATHODE. Stakhanov, I. P.; Shcherbinin, P. P. Sov. Phys.-Tech. Phys. (Engl. Transl.); 14: 1205-11(Mar 1970).
Translated from Zh. Tekh. Fiz.; 39: 1607-16(Sep 1969).

A solution of the transport equation for fast electrons is presented and the electron distribution function close to a nonemitting electrode is investigated. The electron flux through the potential barrier (for a given plasma density) and the extrapolation length for electrons are calculated. (auth)

37477 THERMAL RADIATION OF CERTAIN CONVEX PLASMA BODIES. II. INHOMOGENEOUS SPHERE. Nazarenko, L. A.; Yakimenko, I. P. (Kharkov Inst. of Radioelectronics). Sov. Phys.-Tech. Phys. (Engl. Transl.); 14: 1030-3(Feb 1970).
Translated from Zh. Tekh. Fiz.; 39: 1365-71(Aug 1969).

The theory of equilibrium thermal fluctuations in electrodynamics forms a basis for a formal solution for the problem of thermal radiation of an inhomogeneous plasma sphere whose dielectric constant is a function of the radius. (auth)

37478 MULTIPOLE DEGENERACY OF THE EIGENFREQUENCIES OF A PLASMOID AND ITS EFFECT ON RESONANT RADIATION-PRESSURE. Levin, M. L.; Muratov, R. Z. Sov. Phys.-Tech. Phys. (Engl. Transl.); 14: 1285-7(Mar 1970).
Translated from Zh. Tekh. Fiz.; 39: 1712-14(Sep 1969).

It is shown that for small plasmoids, in addition to the known eigenfrequency degeneracy due to the symmetry of the plasmoid shape, there may be a degeneracy of the oscillation eigenfrequencies (which the authors call "multipole" degeneracy) produced by the asymmetry of the plasmoid, and which is therefore absent in the case of a plasma sphere. Multipole degeneracy affects the nature of the resonant interaction of the plasmoid with field of an electromagnetic wave. If the frequency of a wave incident on the cluster coincides with one of the multipole-degeneracy frequencies, the radiation-pressure force on the plasmoid is significantly different (in both magnitude and, in general, direction) from its resonant value in the absence of degeneracy. An equation is given for the momentum carried off by the radiation of a coherent system consisting of "a dipole plus a quadrupole." Expressions are also given for the radiation-pressure force on a prolate spheroidal plasmoid at resonance under conditions of dipole-quadrupole degeneracy. (auth)

Production

37479 PLASMA PRODUCTION IN THE TORNADO DEVICE. Galechyan, G. A.; Peregud, B. P. (Ioffe Physical-Technical Inst., Leningrad). Sov. Phys.-Tech. Phys. (Engl. Transl.); 14: 1272-6 (Mar 1970).
Translated from Zh. Tekh. Fiz.; 39: 1696-1702(Sep 1969).

The results of an investigation into the production of plasma in the Tornado II experiment are presented. It is shown that large scale instabilities occur in the plasma during decay and that the plasma lifetime is proportional to the square of the magnetic confinement field. (auth)

37480 PRODUCTION OF MULTIPLY-CHARGED IONS BY INTERACTION BETWEEN A POWERFUL LASER PULSE AND A SOLID. Apollonov, V. V.; Bykovskii, Yu. A.; Degtyarenko, N. N.; Elesin, V. F.; Kozyrev, Yu. P.; Sil'nov, S. M. (Engineering Physics Inst., Moscow). JETP Lett. (USSR) (Engl. Transl.); 11: 252-7(20 Apr 1970).
Translated from Zh. Eksp. Teor. Fiz. Pis'ma Redaktsiyu: 11: 377-81(20 Apr 1970).

A high-temperature plasma was produced by Nd-glass laser irradiation of Co, Ag, Ta, W, and Bi at powers up to 2 GW. A charge multiplicity of up to 25 was obtained with Co; for the other targets, Ag^{16+}, Ta^{20+}, W^{19+}, and Bi^{19+} ions were produced. Experimental and statistically reduced mass-spectrometer oscillograms are shown for Co, and it is shown that ions of C, N, and O impurities cannot account for the higher charges. Calculations of ionization multiplicity were made and found to be in agreement with experiment. (D.L.C.)

Stability

Refer also to abstract 37513.

37481 (IPPJ–91) SUPPRESSION OF DRIFT WAVE INSTABILITY BY RF ELECTRIC FIELD. Nishida, Y.; Tanibayashi, M.; Ishii, K. (Nagoya Univ. (Japan). Inst. of Plasma Physics). Jun 1970. 9p. Dep. CFSTI (U. S. Sales Only).

The suppression of drift instabilities in a dc discharge plasma is observed by applying a homogeneous rf electric field. Upon stabilization, the instability amplitude is reduced by more than a factor of 30 and concomitantly, decrease of plasma loss across the magnetic field is observed. (auth) (NSA of Japan)

37482 FLUTE INSTABILITY IN A CURRENT-CARRYING PLASMA. Rosinskii, S. E.; Rukhlin, V. G. (Lebedev Inst. of Physics, Moscow). Sov. Phys.-Tech. Phys. (Engl. Transl.); 14: 606-12(Nov 1969).

Translated from Zh. Tekh. Fiz.; 39: 805-15(May 1969).

The permittivity tensor is derived for an inhomogeneous collisionless plasma that carries a current in a longitudinal magnetic field. The stability of the equilibrium configuration of the plasma against small flute perturbations was studied. The self magnetic field of the current (the pinch effect) is taken into account. It is shown that the presence of a current flowing along the magnetic lines of force does not modify the well-known Suydam criterion. However, for a plasma of sufficiently low pressure the stability criterion obtained by Mikhailovskii (for plasma without a current) deteriorates in the presence of a current and assumes the form $\Theta > 4(a/R)\sqrt{(m_e/m_i)}[1 + (v_A^2/c^2)][1 + (u_0^2/u_{crit}^2)]$. The effect of a finite ion Larmor radius on the stability is also studied. It is shown that the stabilizing effect of a finite ion Larmor radius (the Rosenbluth criterion) deteriorates in the presence of a current at sufficiently low pressure. The effect of the current becomes important even for current velocities that are small in comparison with thermal particle velocities, $v_0^2 > u_{crit}^2 \sim v_{Te}^2(a/R)$. (auth)

37483 CRITERION FOR HYDROMAGNETIC STABILITY OF PLASMA IN THE NEIGHBORHOOD OF THE MAGNETIC AXIS. Solov'ev, L. S. Dokl. Akad. Nauk SSSR; 182: 1052-4(11 Oct 1968). (In Russian).

A general criterion of arbitrary equilibrium plasma stability is analyzed. It is found that the integrand in the criterion of plasma stability in the vicinity of the magnetic axis is a function of 9 parameters: the curve and torsion of magnetic axis, elliptic pre-axis cross sections of magnetic surfaces, parameters of asymmetry, rate of cross section torsion, changes in longitudinal field, ratio of j_ϕ/B_ϕ = constant, and pressure. (R.V.J.)

37484 CHARACTERISTIC INSTABILITY OF AN ELECTRON GAS OF UNIFORM DENSITY. Davidson, R. C.; Krall, N. A. (Univ. of Maryland, College Park). Phys. Lett., A; 32: 187-8 (9 Jun 1970).

A characteristic instability of a magnetically confined pure electron gas of density $\frac{1}{3} < 2\omega_p^2\Omega_c^2 < 1$ is discussed. (auth)

37485 TURBULENCE IN TOROIDAL SYSTEMS. Kadomtsev, B. B.; Pogutse, O. P. pp 249-400 of Reviews of Plasma Physics. Vol. 5. /Leontovich, M. A. (ed.). New York; Plenum Publishing Corporation (1970).

All the basic plasma instabilities that pertain to a toroidal geometry are discussed along with the associated macroscopic effects. The following sections are included: (1) hydromagnetic stability, (2) drift dissipative instabilities, (3) trapped-particle instability, (4) hf instabilities, (5) helical magnetic cells, (6) thermal convection of a current-carrying plasma, (7) transport of particles and heat by the temperature drift instability, (8) anomalous diffusion due to trapped particles, and (9) diffusion in small-shear systems. (M.O.W.)

37486 CYCLOTRON INSTABILITIES IN AN ANISOTROPIC PLASMA. Timofeev, A. V.; Pistunovich, V. I. pp 401-45 of Reviews of Plasma Physics. Vol. 5. /Leontovich, M. A. (ed.). New York; Plenum Publishing Corporation (1970).

A generalization was made of results obtained in investigations of the stability of a plasma in a magnetic field when the velocity distribution is not isotropic. (M.O.W.)

37487 STABILIZATION OF LARGE-SCALE PLASMA INSTABILITIES BY FEEDBACK. Arsenin, V. V. Sov. Phys.-Tech. Phys. (Engl. Transl.); 14: 1166-70(Mar 1970).

Translated from Zh. Tekh. Fiz.; 39: 1553-9(Sep 1969).

The stability of a bound plasma is analyzed in the presence of a feedback system that drives perturbation fields outside the plasma and mixes two spatial modes that are uncoupled in the linear approximation. When feedback is used, mode superposition becomes a characteristic of the problem. Since the dispersion equation contains contributions from both modes, the frequency spectrum can differ greatly from the spectrum of a free plasma. The possibility of achieving stabilization, using a servo-system for surface-wave perturbations, was demonstrated with the aid of two examples: flute oscillations in a simple mirror field and oscillations of a z pinch. It was shown that the z pinch can be stabilized by feedback when the current exceeds the familiar Kruskal–Shafranov limit; in the flute-instability problem the addition of higher modes to the first azimuthal mode provides finite Larmor-radius stabilization (Rosenbluth, Krall, Rostoker). (auth)

37488 ELECTROSTATIC INSTABILITY CRITERION FOR A PLASMA WITH AN IRREGULAR DISTRIBUTION FUNCTION. Zherebtsov, V. A. Sov. Phys.-Tech. Phys. (Engl. Transl.); 14: 1212-15(Mar 1970).

Translated from Zh. Tekh. Fiz.; 39: 1617-21(Sep 1969).

An electrostatic instability criterion is obtained for a plasma with a distribution function having discontinuities of the first kind and inflection points. It is shown that a distribution function is unstable if it has an inflection point at a minimum or if it satisfies the conditions $\Delta_m > 0$ and $\psi'(c_m - 0) < 0$ or $\Delta_m < 0$ and $\psi'(c_m + 0) > 0$ at a point of discontinuity c_m [where $\Delta_m = \psi(c_m + 0) - \psi(c_m - 0)$; $\psi(w) = \Sigma_\alpha Q_\alpha F_\alpha(w)$; Ω_α is the plasma frequency of the α species and $F_\alpha(w)$ is the normalized distribution function]. (auth)

37489 STABILITY OF A MAGNETIZED PLASMA IN A HIGH-FREQUENCY FIELD. Andreev, N. E. (Lebedev Inst. of Physics, Moscow). Sov. Phys.-Tech. Phys. (Engl. Transl.); 14: 1171-9(Mar 1970).

Translated from Zh. Tekh. Fiz.; 39: 1560-72(Sep 1969).

An investigation has been made of the stability of a magnetized plasma in a high-frequency electric field and a constant uniform magnetic field, with arbitrary mutual orientation. In a strong magnetic field in which the electron cyclotron frequency is greater than the field frequency the magnetosonic wave can be unstable. Conditions have been found for the excitation of an aperiodic short-wave instability; the direction of propagation of the most unstable mode is determined. The growth rate in a strong magnetic field is independent of both the frequency of the hf field and the magnitude of the magnetic field. (auth)

Thermonuclear Processes

Refer also to abstract 38016.

37490 (MATT-741) ONE-MEGAJOULE INDUCTIVE ENERGY STORAGE SYSTEM USING IGNITRON SWITCHING. Simon, E. D.; Bronner, G. (Princeton Univ., N. J. Plasma Physics Lab.). Apr 1970. Contract AT(30-1)-1238. 30p. Dep. CFSTI.

The design of the energy storage system is described and operating test results are presented. (M.O.W.)

37491 (STI/PUB-23) WORLD SURVEY OF MAJOR FACILITIES IN CONTROLLED FUSION. Nuclear Fusion, Special Supplement, 1970. (International Atomic Energy Agency, Vienna (Austria)). 1970. 257p. IAEA $6.00.

All major controlled thermonuclear experiments throughout the world are listed according to location and type of device. Brief descriptions of each experiment and major results of each are given. (M.O.W.)

37492 (UCRL-72493) SOME NEUTRONIC ASPECTS OF A DT FUSION REACTOR. Lee, J. D. (California Univ., Livermore. Lawrence Radiation Lab.). 28 May 1970. 44p. (CONF-700614-1). Dep. CFSTI.

From Symposium on Fusion Reactor Design, Lubbock, Tex.

Fusion reactors based on the deuterium–tritium (DT) fusion reaction must produce tritium to be a viable power source. A survey of papers on the subject shows that attractive tritium production looks achievable. Some other neutronic considerations of DT fusion power are also discussed. (auth)

37493 EVALUATION OF THE EFFECT OF ELECTROMAGNETIC FORCES ON THE CHANNEL OF A CONSTRICTED INDUCTION DISCHARGE. Dymshits, B. M.; Koretskii, Ya. P. (State Inst. of Applied Chemistry, Leningrad). Sov. Phys.-Tech. Phys. (Engl. Transl.); 14: 779-82(Dec 1969).

Translated from Zh. Tekh. Fiz.; 39: 1039-43(Jun 1969).

Estimates are offered on the effect of electromagnetic forces on the channel of a constricted induction discharge at elevated pressures. The equations of magnetohydrodynamics and the experimental data are utilized. The estimates show that the axial acceleration of the plasma is determined primarily by interaction with the field established by the inductor. The results show that the electromagnetic forces must be taken into account when calculating the parameters of an induction discharge, since they can have a pronounced effect on transport processes. (auth)

37494 INVESTIGATION OF THE ENERGY TRANSFER EFFICIENCY FOR A PULSED INDUCTION DISCHARGE. Andreev, S. I.; Baikov, O. G.; Dashuk, P. N.; Sergeenkova, E. A.; Yarysheva, M. D. Sov. Phys.-Tech. Phys. (Engl. Transl.); 14: 774-8(Dec 1969).

Translated from Zh. Tekh. Fiz.; 39: 1032-8(Jun 1969).

The energy transfer efficiency for a noninductive capacitor discharge at conditions near the upper limit of rate of current increase in xenon, argon, and neon plasmas was investigated. It was found that the most efficient energy transfer to the plasma (of the order of 80%) occurs when multi-turn exciting solenoids are used, and takes place under conditions of high plasma conductivity as determined by its temperature. The temperature reached 25,000°K for a xenon discharge at pressures from 2 to 50 torr. Data are presented for the relative spectral radiant energy distribution. (auth)

37495 POSSIBILITY OF OBTAINING A MINIMUM-B CONFIGURATION IN A HELICAL MAGNETIC FIELD. Romanov, S. S. (Physical-Technical Inst., Kharkov). Sov. Phys.-Tech. Phys. (Engl. Transl.); 14: 851-2(Dec 1969).

Translated from Zh. Tekh. Fiz.; 39: 1130-2(Jun 1969).

In order to obtain closed magnetic surfaces one uses helical fields; these are produced by 2n current-carrying helices (n being the multipolarity of the helix), together with a longitudinal magnetic field. When n = 1, the magnetic axis is at a specific distance from the geometric axis; this occurs first because two helices that are fed with equal currents produce magnetic surfaces whose cross sections close to the axis are ellipses with constant orientation of the major axis, and second because of the low order of symmetry (in this case this order is unity). It is shown that the orientation of the major axis of the ellipse does not remain constant when the currents in the coils are not identical ($I_1 \neq I_2$). This makes it possible to produce a magnetic well near the magnetic axis. (M.O.W.)

37496 ENERGY BALANCE AND FEASIBILITY OF SELF-SUSTAINING THERMONUCLEAR REACTION IN A MIRROR DEVICE. Sivukhin, V. D. pp 497-525 of Reviews of Plasma Physics. Vol. 5. /Leontovich, M. A. (ed.). New York; Plenum Publishing Corporation (1970).

A review of similar work by both Russian and American authors is presented. The loss of particles due to Coulomb collisions is considered and all other mechanisms that can cause particle loss are neglected. (M.O.W.)

37497 PLASMA INDUCTION SOURCE WITH REDUCED IMPURITY CONTENT. II. Kossyi, I. A.; Shpigel, I. S. (Lebedev Inst. of Physics, Moscow). Sov. Phys.-Tech. Phys. (Engl. Transl.); 14: 486-90(Oct 1969).

Translated from Zh. Tekh. Fiz.; 39: 647-52(Apr 1969).

Measurements with electrostatic probes have shown that in a conical induction source the superposition of the quasi-constant fields of a ring multipole network on the discharge region causes the plasma to be detached from the chamber wall during the entire discharge time and in all cross sections of the conical loop. It follows from spectral measurements that localization of the plasma production process is accompanied by a considerable decrease in impurity content in the plasmoid emitted by the source. (auth)

37498 LIMITING VELOCITY OF PLASMOIDS IN ELECTRODYNAMIC ACCELERATORS. Grigor'ev, V. N. (All-Union Electrotechnical Inst., Moscow). Sov. Phys.-Tech. Phys. (Engl. Transl.); 14: 491-5(Oct 1969).

Translated from Zh. Tekh. Fiz.; 39: 653-9(Apr 1969).

The motion of a current-carrying conductor between conducting walls is investigated. The motion occurs in a steady magnetic field perpendicular to the axis of the conductor and the surface of the walls. It is shown that there exists a stationary stable condition if the external magnetic field is small compared to the self-field of the conductor. The limiting velocity found earlier in plasma accelerators and the stability of the current filaments are explained by the induced interaction of the currents with plasma formed from material evaporated from the walls and electrons. (auth)

37499 LITHIUM YIELD FROM A SUPERSONIC LITHIUM-VAPOR JET. D'yachkov, B. A.; Krivoruchko, S. M.; Petrusha, V. Yu. Sov. Phys.-Tech. Phys. (Engl. Transl.); 14: 686-91(Nov 1969).

Translated from Zh. Tekh. Fiz.; 39: 918-25(May 1969).

A procedure for measuring the absolute concentrations of lithium atoms at values to 10^5 atoms/cm^3 is developed. Measurements of the lithium yield from a vapor-jet lithium neutralizer with a 65-mm aperture and jet thicknesses to 4×10^{15} atoms/cm^2 are reported. The feasibility of using a supersonic lithium-vapor jet in the neutralizer of a thermonuclear device is indicated. (auth)

37500 CONTROLLED NUCLEAR FUSION. Pease, R. S. (Culham Lab., Abingdon, Eng.). Atompraxis; 16: 169-74(May-Jul 1970).

The latest developments in controlled nuclear fusion are reviewed. The basic problems associated with nuclear fusion are explained and the various methods of confinement at present under examination are reviewed. Reference is made to the magnetic method of confinement which, at present, is the principal means of isolation and to the problems of confining plasma by this means. The results of some experimental work are included along with a review outlining future possibilities. Dimensions of a possible reactor are included in a section devoted to likely future development trends, in which it is suggested that development costs might be of the order of $100,000,000. In conclusion, one of the confinement systems has to be selected for intensive development of a fusion reactor and great care must be taken to ensure that the critical judgments cover the development potential and the economics of the technological solutions available. Magnetic confinement seems the most likely method to be adopted at the present time and it is in this area where most of the unexpected advances are likely to be made in the next few years. (D.L.C.)

37501 APPROXIMATE THEORY FOR AMPLIFICATION OF MAGNETIC FIELDS. Kalitkin, N. N.; Tsareva, L. S. (Inst. of Applied Mathematics, Moscow). Sov. Phys.-Tech. Phys. (Engl. Transl.); 14: 1050-4(Feb 1970).

Translated from Zh. Tekh. Fiz.; 39: 1397-1404(Aug 1969).

The compression of magnetic field by a moving shell of finite conductivity which is heated in the process of compression is investigated. The shell material is assumed to be an incompressible fluid (which is justified in fields up to 3 to 4 MOe), and the diffusion of the magnetic field into the shell is calculated from the skin depth. Under these approximations the mathematical problem reduces to the solution of a system of three ordinary differential equations. Accurate solutions can be obtained in a number of cases. Numerical data are presented which agree quite well with experiment. (auth)

37502 ANALOGUE COMPUTATION FOR FUSION RESEARCH AT THE CULHAM LABORATORY. Read, A. H.; Sinton, E. K. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). pp 41-9 of Analog and Hybrid Computation Applied to Nuclear Energy. Brussels, Presses Academiques Europeennes (1969).

From International Symposium on Analogue and Hybrid Computation Applied to Nuclear Energy, Versailles, France. See CONF-680941.

The use of an electronic analogue computer to study some of the engineering and physics problems at the Culham Laboratory and typical examples of the problems encountered are described. High-power electrical circuits form a large and expensive part of most plasma containment experiments and analogue computer studies are used to indicate the transient behavior of these circuits under both operational and fault conditions. A study of the circuit used for a linear pinch discharge experiment, including the nonlinear effect of the plasma as it is compressed, is used as an illustration. The component parts of a fusion machine installation, such as spark gap, switches, cables, coils, etc, are complex items requiring the application of considerable technological skill in their development. Analogue studies of performance of many of these components under operational conditions are regularly carried out and two examples are presented. The first concerns a method of assessing the discharge performance of a 62.5-kJ superconducting magnet and the effectiveness of a nonlinear protection element following a wire quench in the coil. The second shows how the interdependent electrical and mechanical differential equations that describe the operation of a rivet switch were set up on the computer to assess the performance of the switch. Problems with a physics bias were also solved using an analogue computer and two examples are given. The first shows how the computer was used to reproduce experimental solar chromosphere spectral line profiles by solving the radiative transfer equation. To obtain rapid solutions very flexible function generators were designed to simulate the three unknown functions in the equations. The second and final example demonstrates an analogue computer solution of the equations of motion of a single charged particle in a magnetic mirror system. A photoformer technique was used to generate the magnetic field functions for this problem. (auth)

Wave Phenomena

Refer also to abstracts 37346, 37350, 37458, and 37466.

37503 (IPPJ-89) CORRECTION TERM OF LANDAU DAMPING DUE TO TRAPPED PARTICLES. Sugihara, Ryo; Sakai, Jun-ichi (Nagoya Univ. (Japan). Inst. of Plasma Physics). Jun 1970. 9p. Dep. CFSTI (U. S. Sales Only).

An approximate expression for the damping coefficient of an electron plasma wave with a finite amplitude is obtained. It is given in the form, $\gamma_{NL}(\tau) = \gamma_L [1 - (\tilde{E}_0^2/64)(\frac{2}{3}\tau^3 - \tau^2 + \tau - \frac{1}{2} + \frac{1}{2}e^{-2\tau})]$ where γ_L and γ_{NL} stand for "the linear and the nonlinear Landau damping

coefficients." Here τ and $\bar{E}(\tau)$ are adequately stretched time and electric field, and $\bar{E}_0 = \bar{E}(0)$. The above expression is valid for $\tau \ll \omega_b^{-1}$ where ω_b is the bouncing frequency of electrons trapped in a potential trough of the wave. (auth) (NSA of Japan)

37504 STUDIES OF SIMPLE WAVES IN PLASMA WITH ANISOTROPIC PRESSURE. Baranov, V. B. Izv. Akad. Nauk SSSR, Mekh. Zhidk. Gaza; No. 2, 6-13(Mar-Apr 1970). (In Russian).

A system of magnetohydrodynamic equations in the Chew, Goldberger, and Low approximation without the limiting hydrodynamic parameters was obtained for simple wave propagation in plasma. The curve shapes for slow and fast magnetosonic waves were developed, and it was established that such waves have a tendency to break. (R.V.J.)

37505 NONLINEAR THEORY OF WAVES IN A BOUNDED MAGNETOACTIVE PLASMA. Kondratenko, A. N. (Physical-Technical Inst., Kharkov). Ukr. Fiz. Zh.; 15: 745-51(May 1970). (In Russian).

Supposing a small field amplitude and using the asymptotic method, nonlinear boundary conditions and a surface-wave field in magnetoactive plasma were found with an accuracy up to the second term of the field amplitude. It is shown that the surface waves are unstable in some regions of the dispersion curves, exciting volume waves in the second approximation that propagate into plasma. The phenomenon of ion heating with a fast magnetosonic wave is explained by a low-frequency instability of a nonlinear drift of plasma particles across the magnetic field. (auth)

37506 PROPAGATION OF SURFACE WAVES IN A MAGNETOACTIVE PLASMA. Kotsarenko, N. Ya.; Fedorchenko, A. M. (Kiev State Univ.). Sov. Phys.-Tech. Phys. (Engl. Transl.); 14: 853-4(Dec 1969).

Translated from Zh. Tekh. Fiz.; 39: 1132-4(Jun 1969).

Surface waves propagating along the magnetic field are investigated. Solutions of the Maxwell equations in the form exp $[(\omega/c)\tau x]$ exp $[i(\omega t - kz)]$ are investigated. In order to satisfy the Maxwell equations in vacuum, $\tau = -\tau_0 = -(n^2 - 1)^{1/2}$, where $n = ck/\omega_p$. (M.O.W.)

37507 APPLICATION OF THE RECIPROCITY THEOREM TO SCATTERING OF ELECTROMAGNETIC WAVES BY FLUCTUATIONS IN A BOUNDED PLASMA. Yakimenko, I. P. (Kharkov Radio-Electronics Inst.). Sov. Phys.-Tech. Phys. (Engl. Transl.); 14: 602-5(Nov 1969).

Translated from Zh. Tekh. Fiz.; 39: 800-4(May 1969).

The use of the reciprocity theorem for determining the scattering cross section of electromagnetic waves by fluctuations in electron density in a bounded plasma is examined in the light of correlation theory. The relations obtained on the basis of this theorem have general significance since they do not depend on the shape, size, or electromagnetic properties of the scattering object or on the frequencies and type of the incident waves. It is shown that, in the Born approximation, the results go over into the well-known theory of electromagnetic wave scattering by fluctuations in an unbounded plasma. The method can also be used to develop a theory describing a broad class of nonlinear effects in bounded plasmas (assuming weak nonlinearity). (auth)

37508 NONLINEAR WAVES IN A THREE-COMPONENT PLASMA. Pataraya, A. D.; Adzhiashvili, D. S. (Inst. of Physics, Tbilisi, USSR). Sov. Phys.-Tech. Phys. (Engl. Transl.); 14: 453-5(Oct 1969).

Translated from Zh. Tekh. Fiz.; 39: 602-6(Apr 1969).

The structure of isolated waves propagating at right-angles to a magnetic field in a three-component plasma was investigated earlier. In the present work, nonlinear isolated waves propagating obliquely with respect to a magnetic field in a cold, collision-free, three-component plasma are studied. A condition is obtained for the existence of compression and rarefaction waves. A solution is derived for the problem of stationary motion for nonlinear small-amplitude waves, and a condition is obtained for the existence of a depression in the center of an isolated compression wave. The Korteveg-de Vries equation is derived for fast magneto-acoustic compression waves. (auth)

37509 ELECTROMAGNETIC AND ELECTROSTATIC BERNSTEIN MODES IN A WARM, COLLISIONLESS MAXWELL PLASMA. Fredricks, R. W.; Scarf, F. L. (TRW Systems, Redondo Beach, Calif.). pp 97-107 of Plasma Waves in Space and in the Laboratory. Vol. I. /Thomas, J. O. (ed.). New York; American Elsevier Publishing Co., Inc. (1969).

From Conference on Plasma Waves in Space and in the Laboratory, Roeros, Norway. See CONF-680455-(Vol.1).

Results are presented of studies of Bernstein modes for the following two cases: (1) cold plasma magneto-ionic theories using the Vlasov transport equations for particle species coupled to the full set of Maxwell's equations; (2) warm plasma electrostatic theory using the Vlasov equations coupled only to Poisson's equation. (M.O.W.)

37510 REVIEW OF PLASMA RESONANCES. Johnston, T. W. (RCA Victor Research Labs., Montreal). pp 109-22 of Plasma Waves in Space and in the Laboratory. Vol. I. /Thomas, J. O. (ed.). New York; American Elsevier Publishing Co., Inc. (1969).

From Conference on Plasma Waves in Space and in the Laboratory, Roeros, Norway. See CONF-680455-(Vol.1).

Plasma resonances for various cases are briefly discussed. The review is presented under the following headings: (1) unbounded uniform plasmas, (2) bounded uniform plasmas, (3) nonuniform plasmas, and (4) nonlinear effects. A usable listing of references is also included. (M.O.W.)

37511 PLASMA RESONANCES IN LABORATORY PLASMAS. Delcroix, J. L.; Constantin, A.; Leprince, P.; Pointu, A. M.; Pomeau, Y. (Faculte des Sciences, Orsay, France). pp 195-228 of Plasma Waves in Space and in the Laboratory. Vol. I. /Thomas, J. O. (ed.). New York; American Elsevier Publishing Co., Inc. (1969). (In French).

From Conference on Plasma Waves in Space and in the Laboratory, Roeros, Norway. See CONF-680455-(Vol.1).

The oscillations produced in a cylindrical plasma column or radius R excited by electromagnetic waves produced by conductors exterior to the plasma are studied. These are called Tonks-Dattner resonances. The discussion covers some elementary theoretical results, the principal dipolar resonance and the model of cold plasmas, secondary resonances, voltage rise of the resonances, and nonlinear effects. (J.F.P.)

37512 THEORY OF PLASMA WAVES AND INSTABILITIES. Rowlands, G. (Univ. of Warwick, Eng.). pp 417-36 of Plasma Waves in Space and in the Laboratory. Vol. I. /Thomas, J. O. (ed.). New York; American Elsevier Publishing Co., Inc. (1969).

From Conference on Plasma Waves in Space and in the Laboratory, Roeros, Norway. See CONF-680455-(Vol.1).

The theoretical fundamentals of waves and instabilities in plasmas are described as follows: (1) plasma equations, (2) the collision term, (3) linear theory, (4) magnetic field effects, and (5) nonlinear theory. (M.O.W.)

37513 VLF MODES AND INSTABILITIES IN NONUNIFORM PLASMA. Stringer, T. E. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). pp 475-86 of Plasma Waves in Space and in the Laboratory. Vol. I. /Thomas, J. O. (ed.). New York; American Elsevier Publishing Co., Inc. (1969).

From Conference on Plasma Waves in Space and in the Laboratory, Roeros, Norway. See CONF-680455-(Vol. 1).

The effect of inhomogeneity in the plasma parameters on propagation at frequencies less than or comparable with the ion cyclotron frequency is discussed. Modes at frequencies much less than the ion cyclotron frequency are also described. (M.O.W.)

37514 EFFECT OF THE ELECTRON DRIFT ON THE DAMPING OF ION-ACOUSTIC WAVES. Kondo, K.; Fujiwara, M. (Nagoya Univ., Japan). Phys. Lett., A; 32: 158-9(9 Jun 1970).

It was observed that Landau damping of ion-acoustic waves was reduced clearly by the interaction between waves and drifting electrons. (auth)

37515 ION ACOUSTIC WAVE-SHEATH INTERACTION. Widner, M.; Alexeff, I.; Jones, W. D. (Oak Ridge National Lab., Tenn.). Phys. Lett., A; 32: 177-8(9 Jun 1970).

Computer simulation of the nonlinear interaction of an ion-acoustic wave with a Langmuir sheath shows that the motion of the wave in the sheath produces modification in the bulk plasma, which resembles a dispersed, phase-inverted reflection. (auth)

37516 ANOMALOUS ABSORPTION OF MICROWAVE POWER BY A PLASMA AT SUPERCRITICAL ELECTRON DENSITIES. Golant, V. E.; Krivosheev, M. V. (Leningrad Polytechnical Inst.). Sov. Phys.-Tech. Phys. (Engl. Transl.); 14: 719-20(Nov 1969).

Translated from Zh. Tekh. Fiz.; 39: 958-9(May 1969).

The effective absorption of microwave power in a low-pressure positive column was considered earlier for a wide range of magnetic fields. Strong absorption is also observed under similar conditions when there is no magnetic field if the electron density is above the critical value. Experiments were performed in the frequency range ~3000 MHz. The experimental device is a quartz tube with inner diameter 1 cm which passes through the center of the broad wall of a rectangular waveguide with a cross section of 7.2 × 3.4 cm. The angle between the tube axis and the waveguide axis is 15° and the length of the waveguide with tube is roughly equal to the wavelength in the waveguide (in vacuum), i.e., $\lambda_g =$

12.6 cm. The discharge is in argon at a pressure of 3×10^{-2} mm Hg. The initial density varies with the discharge current. The density is measured with a Langmuir probe. (M.O.W.)

37517 PLASMA ABSORPTION OF RF ENERGY NEAR THE LOWER HYBRID FREQUENCY. Galaktionov, B. V.; Golant, V. E.; Piliya, A. D.; Shcherbinin, O. N. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Tech. Phys. (Engl. Transl.); 14: 721-3(Nov 1969).

Translated from Zh. Tekh. Fiz.; 39: 960-2(May 1969).

Experiments were conducted in a magnetic mirror field to determine the mechanism responsible for the absorption of hf energy near the lower hybrid frequency. It was concluded that an effective mechanism may be the linear transformation of the incident wave in an inhomogeneous plasma. (M.O.W.)

37518 FORMATION AND INTERACTION OF ION-ACOUSTIC SOLITONS. Ikezi, H.; Taylor, R. J.; Baker, D. R. (Univ. of California, Los Angeles). Phys. Rev. Lett.; 25: 11-14(6 Jul 1970).

The formation and propagation of ion-acoustic solitons are observed experimentally. The character of a solitary pulse is observed to follow the predictions of the Korteweg–de Vries equation with respect to the shape and velocity of the soliton. The interaction between two solitons is modified significantly by dissipation. However, the nonlinear nature of the interactions is confirmed for solitons moving in the same direction. Solitons moving in the opposite direction and colliding have very little effect on each other. (auth)

37519 SOLITARY WAVES IN A THREE-COMPONENT COLLISIONLESS PLASMA. Pataraya, A. D. (Inst. of Physics, Tbilisi, USSR). Sov. Phys.-Tech. Phys. (Engl. Transl.); 14: 456-8(Oct 1969).

Translated from Zh. Tekh. Fiz.; 39: 607-9(Apr 1969).

The structure of solitary waves with finite electron inertia is studied. The profile of solitary small-amplitude compression waves and the condition limiting the Mach number are determined. An analytic study of the detailed structure of large-amplitude solitary waves propagating in cold plasmas across the magnetic field is also presented. (M.O.W.)

37520 EXCITATION OF PLASMA WAVES NEAR THE LOWER HYBRID RESONANCE. Shvets, O. M.; Sotnikov, S. M.; Tarasenko, V. F.; Ovchinnikov, S. S. Sov. Phys.-Tech. Phys. (Engl. Transl.); 14: 459-63(Oct 1969).

Translated from Zh. Tekh. Fiz.; 39: 610-16(Apr 1969).

Experiments on the excitation of magneto-acoustic waves in a coaxial device of the Almaz type are described. The plasma is cylindrical in shape, 100 cm long and 6 cm in diameter, and is located in a corkscrew magnetic field. The stationary magnetic field can be continuously varied from zero to 10 kOe. Two uhf generators are used to study waves near the lower hybrid resonance. The frequency range of these generators is 130 to 150 MHz and each has a power of 30 kW. These generators are connected to the center electrodes in the vacuum chamber. A high-frequency radial electric field is employed to excite magneto-acoustic waves. Hydrogen and helium are used. Measurements of the field strength of waves in the plasma were performed and the intensities of the characteristic spectral lines of the working gases were measured. The strength of the external magnetic field for which the lower hybrid resonances are observed in hydrogen and helium and the shift of the resonance up to the value of the magnetic field that corresponds to the geometric mean of the electron and ion resonances agree quite well with theory as the charged-particle density is varied. The possibility of plasma heating at the lower electron–ion hybrid resonance is noted; the method was also used to heat plasmas with two ion species at the lower ion–ion hybrid resonance. Since magneto-acoustic waves can be generated using not only high-frequency radial electric fields but also other field components, the possibility exists of generation and absorption of waves near the lower hybrid resonance in closed magnetic traps. (auth)

37521 INDUCED SCATTERING OF QUASI-LONGITUDINAL CYCLOTRON WAVES IN A PLASMA. Kropotkin, A. P.; Sholokhov, N. V. (Lebedev Inst. of Physics, Moscow). Sov. Phys.-Tech. Phys. (Engl. Transl.); 14: 472-8(Oct 1969).

Translated from Zh. Tekh. Fiz.; 39: 628-37(Apr 1969).

The induced scattering of cyclotron waves with a low phase velocity on a virtual longitudinal oscillation was studied. The kernels of the nonlinear integro-differential equation are calculated for different types of cyclotron oscillations; this equation determines the rate at which the oscillation energy is transferred in the spectrum. The possibility of energy transfer in the region where strong cyclotron attenuation leads to plasma heating is discussed. With these relationships the effective cross sections for various wave-scattering processes can be calculated. (auth)

37522 INSTABILITY OF AN AFTERGLOW PLASMA IN A MAGNETIC FIELD. Bulanin, V. V.; Golant, V. E.; Zhilinskii, A. P. (Leningrad Polytechnical Inst.). Sov. Phys.-Tech. Phys. (Engl. Transl.); 14: 712-13(Nov 1969).

Translated from Zh. Tekh. Fiz.; 39: 948-50(May 1969).

Electrostatic oscillations in an afterglow plasma are described. A sensitive pickup system was used to detect these electrostatic oscillations because the plasma temperature is low in the afterglow. The spectral characteristics of the oscillations are discussed. (M.O.W.)

37523 NONLINEAR WAVES IN A RELATIVISTIC ELECTRON BEAM. Fainberg, Ya. B.; Shapiro, V. D.; Shevchenko, V. I. (Physical-Technical Inst., Kiev). JETP Lett. (USSR) (Engl. Transl.); 11: 277-80(20 Apr 1970).

Translated from Zh. Eksp. Teor. Fiz. Pis'ma Redaktsiyu; 11: 410-14(20 Apr 1970).

The possibility of exciting large-amplitude currents by enhancing the compensation of the Coulomb repulsion is pointed out. The case of rectangular geometry (electron beam moving along y axis and bounded in x axis) is considered. Hydrodynamic equations are used to describe the beam, and an equation is derived for the maximum amplitude. (D.L.C.)

37524 STATIONARY WAVES IN A MAGNETOACTIVE MULTICOMPONENT COLLISIONLESS PLASMA. Pataraya, A. D. (Inst. of Physics, Tbilisi, USSR). Sov. Phys.-Tech. Phys. (Engl. Transl.); 14: 1288-91(Mar 1970).

Translated from Zh. Tekh. Fiz.; 39: 1714-17(Sep 1969).

Nonlinear waves propagating along an external magnetic field in a multicomponent quasineutral cold plasma are considered. The behavior of a nonlinear wave in the region in front of the wave is also considered. A region of variation of Mach number is established in a three-component plasma for the case in which electron inertia is neglected. Then, the profile of a solitary wave in a three-component plasma is found for the case in which electron inertia is neglected at some values of the parameters of the unperturbed plasma. (auth)

37525 SLOW NONELECTROSTATIC WAVES IN AN INHOMOGENEOUS PLASMA. Fridman, A. M. Sov. Phys.-Tech. Phys. (Engl. Transl.); 14: 1019-25(Feb 1970).

Translated from Zh. Tekh. Fiz.; 39: 1350-9(Aug 1969).

It is shown that nonelectrostatic flute perturbations can grow in the region of strong ion Landau damping $\omega \ll |k_z|V_{Ti}$ (ω is the oscillation frequency; V_{Ti} is the ion thermal speed; k_z is the component of the wave vector in the direction of the magnetic field) in an inhomogeneous plasma with nonzero magnetic field line curvature. The oscillation frequency is equal to the particle drift frequency in the magnetic field due to gradients in the density; the imaginary part of the frequency can be of the same order as the real part. The instability is strongly kinetic in nature and develops near gradients in the equilibrium plasma in the presence of certain anisotropic temperatures. The propagation criterion for nonelectrostatic perturbations with a phase velocity smaller than the ion thermal speed has been found. It is of the form $\omega > k_\perp r_i k_z V_A$ ($k_\perp$ is the component of the wave vector in the direction perpendicular to the magnetic field; r_i is the ion gyro radius; V_A is the Alfvén speed). (auth)

37526 CONTRIBUTION TO THE ANALOG CALCULATION AND STUDY OF THE WAVE–PARTICLE INTERACTION IN HIGH-FREQUENCY STRUCTURES IN PLASMA. Collet, R; Ichtchenko, G.; List, D. pp 50-8 of Analog and Hybrid Computation Applied to Nuclear Energy. Brussels, Presses Academiques Europeennes (1969). (In French).

From International Symposium on Analogue and Hybrid Computation Applied to Nuclear Energy, Versailles, France. See CONF-680941.

In order to define the energy exchanges between the high-frequency source and the particles in the plasma accelerators of the CEN, Saclay, the dynamics of the charged particles in a system of high-frequency electromagnetic and nonuniform static magnetic fields were studied. There are zones of strong coupling between the waves and the particles when the gyration frequency of the electrons (or the ions) is near the frequency of the wave. Significant energy transfers result. The choice of the analog calculation is motivated by the purpose (tracing of trajectories and study of the evolution of magnitudes associated with the particle) and by the properties of the differential system obtained. As simple a formulation as possible of the plasma acceleration phenomena is obtained by eliminating parameters whose influence appears negligible in the conditions studies. A solution type is obtained that characterizes the resonance phenomenon. (tr-auth)

Shielding

Refer also to abstracts 37368 and 38069.

37527 (JUL-603-ST, pp 209-12) ACTIVITY AND SHIELDING: SHIELDING FROM X RAYS BY VARIOUS TYPES OF CONCRETE. Sauermann, P. F.; Voelkel, E.; Voss, W. (Kernforschungsanlage, Juelich (West Germany). Zentralabteilung Strahlenschutz). (In German).

Concrete slabs of various composition were prepared and exposed to x radiation. The transmitted amount of x radiation was measured with an ionization chamber in the form of three tables and four diagrams. (H.B.G.)

37528 (JUL-603-ST, pp 213-22) ACTIVITY AND SHIELDING: SHIELDING AGAINST FAST NEUTRONS. Sauermann, P. F.; Schaefer, W. (Kernforschungsanlage, Juelich (West Germany). Zentralabteilung Strahlenschutz). (In German).

Theoretically and experimentally, various compositions of concrete were studied with respect to their protective properties against neutrons. Discrepancies between calculated penetration and actually measured values never exceeded 5.7%; thus, the given mathematical formulas describe the experimental data satisfactorily. From a health physics standpoint, it is concluded that thermal neutrons are of negligible importance. Intermediate energy neutrons play a decisive role and, at concrete thickness in excess of 70 cm, represent a higher percentage than fast neutrons. Because of the failure to detect intermediate energy neutrons by recoil proton counters, this type of equipment should not be used for personnel monitoring. (H.B.G.)

37529 (LNF-70/12) DYNAMIC EFFECTS IN HARD SUPERCONDUCTORS. Note No. 470. Spadoni, M. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). 23 Mar 1970. 25p. Dep. CFSTI (U. S. Sales Only).

The differences between the three classes of known superconductors (i.e., type I, type II, and type III or hard) are discussed. Dissipative phenomena in type II and hard superconductors are accounted for, and flux flow resistivity, flux creep, and flux jumps are dealt with. (89 references) (M.H.R.)

37530 (SC-DR-69-318) MAGYAR: A SINGLE-COLLISION MODEL NEUTRON HEATING CODE FOR COMPONENT DESIGN (USER'S MANUAL). Shishman, Thomas T. (Sandia Labs., Albuquerque, N. Mex.). Jun 1970. 51p. Dep. CFSTI.

A heating code was written to enable component designers to calculate specific energy depositions from neutron irradiations, using the CDC 6600 computer. Three interactions are treated: neutron elastic scattering; inelastic scattering; and neutron-in, charged particle-out reactions. Since the energy absorption coefficients for the various elements, based on these three processes, are not documented, an additional code was generated to compute these for the 59 elements considered most relevant to component work, and the results stored on magnetic tape. The input and output formats of the code were held simple to encourage even those designers who are not normally machine-oriented to use the code for proper consideration of neutron irradiation effects. (auth)

37531 APPLICATION OF THE CARLSON METHOD TO CALCULATIONS OF γ-RAY TRANSMISSION THROUGH SHIELDING. Broder, D. L.; Kulikova, I. N.; Rubanov, S. M.; Trofimov, I. N. This paper was summarized in At. Energ. (USSR); 27: 217-18 (Sep 1969) as paper No. 336/5159. (In Russian).

The S_n method developed by Carlson appears to hold great promise in γ-ray shielding calculations. The Carlson method was used in calculating differential energy spectra, buildup factors in lead, iron, and water, buildup factors in water/lead multilayer geometry; values assigned to μ(the cosine of the angle defining the direction of the flow of particles) were 1, 0.9, 0.6, 0, −0.6, −0.9, −1. The effective attenuation factor of the unscattered radiation from a point source, arrived at through these calculations, was 3% off the exact value; when the interval is broken up into equal subintervals the difference is 13%. Calculations were carried out by a program compiled for the M-20 electronic digital computer. The maximum number of energy groups was 26. As many as 10 energy jumps from group to group can be taken into account in this method. The maximum number of layers must not be in excess of 15, but the number of points entering into the calculations can reach 146. The scattering indicatrix for γ-quanta is specified to six terms of the expansion in Legendre polynomials. Calculations of the differential energy spectra of γ-radiation and of dose buildup factors of γ-radiation in water and lead, from isotropic point sources of energy 6.6 MeV and 8.7 MeV, were performed in order to check the method. The results were found to be in excellent agreement with calculated data obtained by the method of moments. In addition to breakup of the energy interval into groups, breakup into nodal points was also discussed, i.e., determination of the differential energy spectrum in terms of discrete energy values. This means a marked simplification in the Boltzmann equation, with $E_K - E_K$ type transitions vanishing, and also means that the Carlson method becomes an exact method in this case, rather than an iterative method. Node–node type cross sections are determined from the formula $\sigma_l^{n\to m} = \int_{\mu_2}^{\mu_1} (\partial\sigma/\partial\mu) \times (\partial E'/\partial E)] P_l(\mu)\, d\mu$, where $\mu_1 = \mu(E_n E_m)$; $\mu_2 = \mu(E_{n+1} E_m)$; and $\mu(E' E_m) = 1 - [1 - (E'/E_m)] (mc^2/E_m)$. A check was run on the breakup of the energy interval into nodes in the case of γ-quanta of initial energy $E_0 = 1$ MeV. Excellent agreement was found between the calculated data and the results of calculations using other methods, as well as experimental data for a ^{60}Co source. (auth)

37532 INTERMEDIATE NEUTRON DOSE DISTRIBUTION IN CERTAIN MATERIALS. Starodubtsev, S. V.; Vainshtein, G. M.; Stryapunin, V. B. This paper was summarized in At. Energ. (USSR); 26: 540-1(Jun 1969) as paper No. 309. (In Russian).

The flux of intermediate neutrons from the VVR-S reactor was measured in cylindrical slugs of polystyrene, boron, iron, lead, and also in water, air, and a graphite prism by the method of subtracting the 1/v contribution. The slugs were 20 mm in diameter, 30 mm high, and had a wall thickness of 7 mm. In a horizontal channel the slug dimensions were 30 × 200 mm. The specimens were placed at distances of 10, 90, and 180 mm from the end of the channel. The epithermal neutron spectra in the vertical channel in water, polystyrene, iron, and lead agreed within 10%, i.e., within the limits of experimental error due to the small content of moderator nuclei (since the slugs were small) and the large value of the slowing down power of hydrogen. The absorbed dose rates in water, polystyrene, carbon, boron, iron, and lead were computed from the experimental neutron spectra in these materials. The absorbed dose rates were calculated by the formula $D = kN \int_{E_0}^{0.000\,eV} \varphi(E_i) E_i \sigma_{si}(E) dE$, where k is the fraction of the energy transferred, $\varphi(E_i)$ the neutron flux for the given energy interval, and σ_{si} the scattering cross section. The values of the absorbed dose rates in certain materials, measured in a vertical channel at a reactor power of 2000 kW are: H_2O, 20 Mrad/hr; CH, 11 Mrad/hr; C, 0.8 Mrad/hr; B, 1 Mrad/hr; Fe, 0.1 Mrad/hr; Pb, 0.02 Mrad/hr. The same measurements in a horizontal channel at a distance of 30 mm from the core gave: H_2O, 3.4×10^4 rad/hr; CH, 3.8×10^4 rad/hr; C, 2.4×10^3 rad/hr; B, 650 rad/hr; Fe, 82 rad/hr; Pb, 8.0 rad/hr. (auth)

37533 GAMMA-RAY BUILDUP FACTOR COEFFICIENTS FOR CONCRETE AND OTHER MATERIALS. Trubey, D. K. (Oak Ridge National Lab., Tenn.). Nucl. Appl. Technol.; 9: 439-41(Sep 1970).

Coefficients for the Berger formula gamma-ray buildup factor are given for ordinary, magnetite, and barytes concrete, air, sand, wood, and lithium hydride. The original data can be reproduced using these coefficients with an error for source energies greater than 2 MeV to generally less than about 5%. Errors for energies 0.5 to 2 MeV may be of the order of 20%. (auth)

37534 INVESTIGATION OF THE ENERGY DISTRIBUTION OF SINGLY SCATTERED AND MULTIPLY SCATTERED GAMMA RADIATION. I. BACKSCATTERED AND ATTENUATED RADIATION. Wechselberger, E. (Univ., Tuebingen, Ger.). Atomkernenergie; 16: 64-70(1970). (In German).

The spectral distributions of gamma radiation from ^{60}Co and ^{137}Cs, attenuated and backscattered by thick slabs of concrete, barite concrete, iron, and lead were measured. The radiation was of the narrow-beam type of 2π geometrical configuration. Gamma rays were recorded by a NaI(Tl) scintillation counter combined with a multichannel pulse-height analyzer. The inherent laws are pointed out by means of some selected spectra. Backscattering decreases with increasing atomic number of the slab material; thus barite concrete shows a smaller backscattering than iron. Barite concrete, and especially lead, furnish eigenradiation. In the case of backscattering of the narrow beam, the spectral regions of single scattering and multiple scattering can be separated. According to the pulse-height distributions and the mean free paths the portion of scattered radiation in the attenuated radiation decreases with increasing atomic number analogous to the backscattered radiation. In contrast to the backscattered radiation, the portion of eigenradiation in the attenuated radiation can even be neglected in the case of lead. (auth)

Solid-State Physics

Radiation Effects

Refer also to abstracts 36576, 36674, 38029, and 38301.

37535 POLARIZATION OF CHANNELED DEUTERONS. Ebel, M. E. (Univ. of Wisconsin, Madison). Phys. Rev. Lett.; 24: 1395-8(22 Jun 1970).

A possible explanation is advanced for the recent experiments by Kaminsky on the polarization of deuterons passed through a magnetized Ni single crystal. The large polarization is attributed to a strong preference for ionization of the deuterium atoms which have an electron spin opposite to the direction of the magnetic field. (auth)

37536 ESR SPECTRA OF POSITIVE HOLES IN IRRADIATED ALKANE GLASSES. Yoshida, Hiroshi (Kyoto Univ.); Shiga, Tetsuo; Irie, Masahiro. J. Chem. Phys.; 52: 4906-8(1 May 1970).

ESR spectra of 3-methylhexane and 3-methylpentane glasses were examined after gamma-ray irradiation at 77°K. The change in the spectrum induced by bleaching ("bleached signal") is a superposition of a singlet spectrum and a novel spectrum, the latter being attributable to positive holes that recombine with the trapped electrons. Effects of addition of viryl ethers and tetramethylethylene are discussed. (D.L.C.)

37537 CHANGES OF ABSORPTION OF LIGHT IN THE VISIBLE ND INFRARED REGIONS IN SAMPLES OF STEATITE CERAMIC B AS A RESULT OF IRRADIATION. Belousov, V. M.; Robotkin, V. L. Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 4, 138-40(1969). (In Russian).

When samples of steatite ceramic B were irradiated by 3.4-MeV protons, 15-MeV betatron radiation, or 200-keV x rays, darkening of the samples occurred in all cases. However, no change in the infrared absorption spectra of the samples was produced by the same irradiation. Three possible types of radio-induced changes are discussed, and it is concluded that the darkening is caused by accumulation of the products of radiolysis in the pores of the ceramic body. (A.G.W.)

37538 INTERACTIONS OF INTERSTITIAL CENTERS WITH MONOVALENT IMPURITIES IN KBr CRYSTALS. Saidoh, Masahiro; Itoh, Noriaki (Nagoya Univ., Japan). J. Phys. Soc. Jap.; 29: 156-61(Jul 1970).

Formation of interstitial centers in pure and Na^+- and Li^+-doped KBr by x irradiation at 4 and 77°K is studied. The results are discussed in terms of the dynamic and static interaction of the interstitial centers with monovalent impurities. It is shown that the interstitial centers are stabilized by the association with the monovalent impurities and that the stability of the complex is higher for Li^+ than for Na^+. The optical transitions of interstitial centers are discussed. (auth)

37539 CHANNELING AND COHERENT BREMSSTRAHLUNG EFFECTS FOR RELATIVISTIC POSITRONS AND ELECTRONS. Walker, R. L. (Univ. of California, Davis); Berman, B. L.; Der, R. C.; Kavanagh, T. M.; Khan, J. M. Phys. Rev. Lett.; 25: 5-8(6 Jul 1970).

Channeling of positrons in silicon single crystals was observed in transmission and scattering measurements for incident energies from 16 to 28 MeV. In addition, the forward bremsstrahlung intensity was established as a new observable of the channeling phenomenon. Enhancement of the low-energy portion of the bremsstrahlung spectrum ($E_\gamma < 1$ MeV) was observed with both positron and electron beams incident along the crystal axes; this enhancement is attributed to coherence effects in bremsstrahlung production. (auth)

37540 ESR SPECTRA FROM PARAMAGNETIC CENTERS IN IRRADIATED $KClO_4$. III. CENTERS APPEARING BETWEEN 10 AND 220°K. Byberg, J. R.; Jensen, S. J. K. (Aarhus Univ., Denmark). J. Chem. Phys.; 52: 5902-10(1 Jun 1970).

ESR spectra of $KClO_4$ crystals irradiated with x rays at 10 and at 26°K contain three "families" of intense signals. The signals are assumed to derive from primary defects constituted by electrons and holes trapped on ClO_4^- ions. The families of signals are assigned to the species ClO_4^{2-}, ClO_4, and $(ClO_4)_2^-$, each trapped in a number of distinct sites. ClO_4^{2-} and ClO_4 appear to be stabilized by intraionic configuration change, whereas interionic configuration change may stabilize $(ClO_4)_2^-$. Thermal processes starting at 30°K result in formation of the secondary defects O_3^- from ClO_4^{2-} and ClO_3 from ClO_4 and in destruction of $(ClO_4)_2^-$. (auth)

37541 RELATION BETWEEN ELECTRONIC CHARACTERISTICS AND CATALYTIC PROPERTIES OF SEMICONDUCTORS UNDER IRRADIATION. Spitsyn, V. I.; Mikhailenko, I. E. (Inst. of Physical Chemistry, Moscow). pp 219-30 of Symposium on Electronic Phenomena in Chemisorption and Catalysis on Semiconductors, held in Moscow, July 2-4, 1968. /Hauffe, K. (ed.). Berlin; Walter de Gruyter and Co. (1969).

See CONF-680729.

Excess charge carriers and defects generated by irradiation change the electrical properties of semiconductors and dielectrics and, consequently, also change their catalytic properties. The discovery of correlations between the catalytic and electrical properties of irradiated solids, used as catalysts in the dehydration of alcohols, is dealt with. Also, catalysts were employed in which radioactive isotopes were incorporated. Investigations of the dehydration of aliphatic alcohols on WS_2 which do not contain mobile hydrogen atoms, have shown an opportunity of using them as catalysts. The dehydration occurs according to the carbonium-ion mechanism and belongs to the donor-type reaction. The dehydration of decyl alcohol on WS_2, made radioactive in a nuclear reactor, has been studied. Under these conditions, an increase in the catalytic activity of WS_2 was detected. Irradiated WS_2 samples, however, exhibited a decrease of the conductivity in comparison with non-radioactive samples. Such a contrary dependence between catalytic activity and conductivity of n-type catalysts for the donor-type reaction of the alcohol dehydration is in agreement with the electron theory of Wolkenstein. The dehydration of aliphatic alcohols and cyclohexanol on $MgSO_4$ with ^{35}S was also investigated. It was found that the catalytic activity depends on the content of ^{35}S. Such a change in catalytic activity depending on radiation intensity is related to stationary charging of the sample and its ionization. This was discussed by Baru and Wolkenstein. If the specific radioactivity is small, then the charging of the sample is the determining factor. If it is large, the ionization begins to become more important. (auth)

37542 ELECTRONIC MECHANISMS OF CATALYTIC AND CHEMISORPTION PROCESSES INDUCED BY IONIZING RADIATION. Zhabrova, G. M.; Vladimirova, V. I.; Gesalov, A. A.; Kadenatsi, B. M. (Inst. of Chemical Physics, Moscow). pp 231-43 of Symposium on Electronic Phenomena in Chemisorption and Catalysis on Semiconductors, held in Moscow, July 2-4, 1968. /Hauffe, K. (ed.). Berlin; Walter de Gruyter and Co. (1969).

See CONF-680729.

The contribution of electrons in heterogeneous catalytic and chemisorption processes may be established by means of ionizing radiation. Catalysts with different widths of the forbidden zone were investigated at low temperatures under irradiation. The catalysts employed were insulators (SiO_2, Al_2O_3, silica–alumina, diamonds, MgO, CaO, and KF), semiconductors (ZrO_2, ZnO, NiO, and CdO), and metals (Pt, Pd, Ni) and, furthermore, graphite. On these solids, the decomposition of cyclohexane and methanol in the adsorbed layer and the chemisorption of hydrogen and oxygen were investigated. Catalytic conversions of molecules adsorbed on insulators and certain semiconductors were induced solely by the radiation energy adsorbed by the bulk of the solid and transferred to its surface. The contribution from post-effect phenomena was negligible compared to the small fraction of processes induced directly by radiation. An increased chemisorption of hydrogen and oxygen by irradiation was observed for ZnO. Only radioinduced chemisorption of the two gases was observed for Al_2O_3. A correlation was found between the electronic properties of the oxides and their chemisorption ability for hydrogen and oxygen under irradiation. Chemisorption of hydrogen significantly increases and that of oxygen decreases the conductivity of the semiconductor. The effects observed at room temperature were irreversible. Radio-induced chemisorption of oxygen on Al_2O_3 was accompanied by a formation of O_2^- radicals. In particular, the forbidden zone width is of decisive influence on the activity of the solids under irradiation. The insulators with a large forbidden band gap are the most active radiation catalysts for the reactions mentioned above. Semiconductors with a narrow forbidden band gap, such as NiO and CdO, furthermore, dispersed metals (Pt, Pd, Ni) and graphite that exhibits metallic conductivity, do not show catalytic activity under irradiation. The catalytic activity under irradiation increases with the increasing width of the forbidden zone of the solid. It was found by ESR studies that the defects caused by radiation, i.e. paramagnetic centers and radicals (CH_3OH, CH_3CHO, C_6H_7), could be detected on active radiation catalysts. It could be demonstrated that the CH_2OH radical formed in the catalytic decomposition of methanol under irradiation is an active intermediate in this process. The change in selectivity of radiation-catalytic processes was found to be a function of surface coverage. A scheme implying formation of adsorbate–hole complexes on the surface and their recombination with excess electrons available in the conduction band, was proposed. Recombination was accompanied by formation of radicals. The importance of free charge carriers generated during irradiation for the chemisorption of oxygen and hydrogen is discussed. (auth)

37543 HALL-EFFECT MEASUREMENTS ON INDIUM-IMPLANTED SILICON. Bergamini, P.; Fabri, G.; Pandarese, F. (CISE, Milan). Appl. Phys. Lett.; 17: 18-20(1 Jul 1970).

Ion implantation of indium in silicon was studied at 30 keV both in random and in channeling conditions. Implantations were performed at room temperature with doses ranging from 1×10^{12} to 1×10^{15} ions/cm^2; surface carrier concentration versus anneal temperature curves were obtained and compared with the behavior

of other group III elements. The anneal behavior of the indium implants after anneal at 700°C and subsequent tin implantation is also discussed. (auth)

37544 MAGNETIC AFTER-EFFECT IN IRRADIATED FERRITES. Trinkler, Ernest; Zaveta, Karel; Moser, Pierre; Marais, Andre (Lettonian Academy of Sciences, Riga. Inst. of Physics, Prague). Compt. Rend., Ser. B; 270: 1191-4 (11 May 1970). (In French).

The magnetic after-effect of poly-crystalline Mn and Ni ferrites irradiated by fast neutrons was studied. An interpretation is given of the very important modification of the after-effect bands and the magnetic permeability after irradiation. (France)

37545 TEMPERATURE DEPENDENCE OF THE F-CENTRE FORMATION BY X-RAYS IN NaCl. Alvarez Rivas, J. L. (Junta de Energia Nuclear, Madrid). J. Phys., C (London); 3: 1242-50 (Jun 1970).

Recently, it has been shown that the first stage of the F-center coloration curve by ionization radiation in NaCl is formed mostly by two exponential growths. These exponentials are not mathematical artifacts but are due to two different coloring mechanisms operative in this first stage. The influence of the irradiation temperature on both exponential growths is presented here. Further evidence on the different nature of these growths was obtained. It is shown that the fast growth is not operative for F-center formation below about 200°K. It was concluded that this mechanism is very closely related to the presence of OH and H impurities in these samples. It is found that the slow mechanism is operative from 77°K up to room temperature. Its formation rate has an activation energy of about 0.1 eV. Thus, it might well be related to the migration of interstitials produced by the ionizing radiation. Its temperature dependence shows the existence of one or more temperature-assisted back reactions. The variation of the slope of the linear stage with the irradiation temperature is also shown. (auth) (UK)

37546 ELECTRON RADIATION DAMAGE AND THE GREEN EDGE EMISSION OF CdS. Bryant, F. J.; Radford, C. J. (Univ. of Hull, Eng.). J. Phys., C (London); 3: 1264-74(Jun 1970).

The behavior of the green-edge cathodoluminescence (100 keV) emission and photoluminescence emission of cadmium sulfide at 4°K was investigated before and after (i) monoenergetic electron irradiation (in the 100 to 400 keV range), (ii) heat treatments in sulfur vapor and cadmium vapor. The shorter wavelength emission band (5136.5 Å), attributed to the recombination of free electrons with bound holes, does not change significantly under electron irradiation at 4°K. The longer wavelength emission band (at approximately 5170 Å), attributed to the recombination of bound electrons with bound holes, is enhanced by irradiation with electrons of sufficient energy to displace sulfur atoms and shifts to higher energies. The analysis of the heat treatment and electron irradiation results, and the results of other workers, permit a discussion on the chemical nature of the defects. (auth) (UK)

37547 COLORATION OF LiF BY 3.0-MeV ^{3}He, ^{40}Ar, ^{84}Kr, AND 2.0-MeV ^{129}Xe IONS. Vander Lugt, K. L.; Comas, J.; Wolicki, E. A. (Naval Research Lab., Washington, D. C.). J. Phys. Chem. Solids; 31: 1361-73(Jun 1970).

From the F-center growth curves, it has been determined that 666 eV and 1150 Ev are expended per F center created by the ^{3}He and ^{40}Ar ions respectively; the curves are linear up to approximately 2.3×10^{18} F/cc and 2.4×10^{18} F/cc, respectively. The optical absorption spectra of the damage produced by the ions have been quantitatively resolved and compared to the damage produced by gamma rays by means of a least squares Gaussian curve fitting computer program. For the ^{40}Ar-, ^{84}Kr- and ^{129}Xe-irradiations the data are best fitted by the formation of 3 bands near 3.22, 2.97 and 2.22 eV and the ^{3}He data by a small band near 2.90 eV. Damage profile curves, obtained by etching, yield penetration depths which agree qualitatively with calculated values and show that the damage is fairly uniform. (auth) (UK)

37548 RADIATION DAMAGE IN MOLECULAR CRYSTALS. Ringel, Herbert. New York; City Univ. of New York (1969). 157p.

Thesis.

The effect of ^{60}Co gamma radiation on some of the electrical and optical properties of high-purity single crystals of anthracene, naphthalene, and phenanthrene was examined. The irradiations were performed at ambient temperature. The lifetimes of electrons and holes in irradiated anthracene was determined from transient photoconductivity measurements. For exposures up to 4000R, the reciprocal lifetimes of both types of carriers vary linearly with dose: $1/\tau = \text{Const.} + \alpha D$, where τ is the carrier lifetime, D the exposure dose in Roentgens, and α has the values 18 sec^{-1} for electrons and 10 sec^{-1} for holes. The density of radiation-induced electron traps, determined by steady state space charge-limited current measurements, if found to increase linearly with exposure dose at a creation rate of 10^{9} cm^{-3} R^{-1}. The behavior of electron lifetimes is interpreted in terms of radioinduced traps with trapping cross sections comparable to the geometric cross section of the anthracene unit cell. The lifetimes of the charge carriers in irradiated naphthalene were found to behave in a manner similar to anthracene. However, because of the low photoresponse of naphthalene, no quantitative values were obtained. In phenanthrene, the magnitude of the reciprocal charge release was found to decrease linearly with radiation dose. The charge release is interpreted as a cooperative phenomenon between the small dipole moments of the molecules. The damage of one molecule hinders the dipole alignment within a distance of 10^{3} molecular sites and causes a decrease of the charge release. A study was also made of the color center production and annealing. Exposure to doses of the order of 10^{8} R produces several color center absorptions in each material. The annealing kinetics for the prominent peaks at 6060Å in anthracene, 7070Å in naphthalene, and 6150Å in phenanthrene have been determined. The anthracene peak at 6060Å grows initially, then decays. This behavior can be interpreted as two consecutive first order reactions with activation energies of 1.0 ± 0.2 eV and 1.5 ± 0.1 eV respectively. For light incident normal to the ab plane and polarized along the a and b crystallographic axes, the absorption maxima were found to occur at different temperatures. This splitting of the polarized absorptions is interpreted as due to a thermal reorientation of the defect in the ab plane. A computer fit to the experimental data supports this kinetic scheme. The 7070Å absorption peak in naphthalene and the 6150Å peak in phenanthrene do not grow but exhibit first order decay with activation energies of 1.0 ± 0.2 eV and 2.7 ± 0.2 eV respectively. The relative magnitudes of the polarized absorptions in naphthalene indicate that a thermal reorientation, similar in nature to that found in anthracene, may have occurred during the irradiation. No evidence for a thermal reorientation was found in phenanthrene. Gas chromatography and ESR experiments indicate that one of the radioinduced defects may arise from the addition of a hydrogen atom to the positions of highest spin density in anthracene, naphthalene, and phenanthrene. (Diss. Abstr. Int. B)

37549 TIME-DEPENDENT RELAXATION OF ALIGNED NUCLEI DUE TO RADIATION-INDUCED VACANCIES IN SOLID GERMANIUM. Bertschat, H.; Christiansen, J.; Mahnke, H.-E.; Recknagel, E.; Schatz, G.; Sielemann, R.; Witthuhn, W. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Phys. Rev. Lett.; 25: 102-4(13 Jul 1970).

The temperature dependence is observed of the alignment of an isomeric state in ^{73}As (426 keV, $9/2^{+}$, $\tau = 8$ μsec), produced by the reaction $^{72}Ge(d,n)^{73}As$ in solid Ge. The relaxation process can be interpreted with a diffusion-controlled time-dependent quadrupole interaction due to radioinduced lattice damage. A diffusion energy of E = 1.3 ± 0.2 eV is assigned to the activation energy for excess vacancy diffusion. This result yields, for the first time, quantitative insight into relaxation mechanisms associated with radiation damage in solids, which may occur when implantation techniques and nuclear reactions are employed. (auth)

Physical Properties

Refer also to abstracts 36904, 36916, and 37212.

37550 (BNL-14630) μ TABLES FOR STEELS AS A FUNCTION OF TEMPERATURE. McInturff, A. D.; Claus, J. (Brookhaven National Lab., Upton, N. Y.). 14 Apr 1970. 11p. Dep. CFSTI.

Hysteresis curves were obtained for three types of steel at three different temperatures, 300, 77, and 4.2°K. These curves were then calibrated and measured, resulting in the μ tables presented. The apparatus consisted of two concentric rectangular pickup coils. The samples consisted of insulated laminations stacked on either side of the inner pickup coil (H) and enclosed by an outer coil. The output of these coils was integrated and displayed on an oscilloscope. The magnetizing force was supplied by an 13-in.-long copper solenoid in whose bore the pickup coils and samples were contained. It was found that the μ's at some given fields were temperature-dependent for the samples tested. B_s (saturation induction) was not a function of temperature for the samples tested. (auth)

37551 (COO-525-32) A STUDY OF THERMAL DIFFUSE X-RAY SCATTERING FROM LEAD. Schuster, Sanford L. (Nebraska Univ., Lincoln. Dept. of Physics). Jun 1969. 201p. Dep. CFSTI.

Thesis.

The measured thermal diffuse x-ray scattering (TDS) from Pb single crystals is compared with calculations made using

lead phonon dispersion curves from slow neutron scattering. The TDS was measured in the longitudinal and transverse branches along the [100] and [111] directions. For the calculations, 100°K dispersion curves corrected to room temperature were used. The one-phonon intensity was calculated directly from the [100] and [111] phonon data, while the two-phonon intensity was calculated using the cross section expressed in terms of atomic force constants. Higher-order scattering was calculated using expansion of the Debye–Jauncey relation in powers of the Debye–Waller factor, and a very small Compton scattering contribution was also calculated. The comparison showed that in all cases, except for some points along the [111] transverse branch, the measured intensity is greater by 10 to 60% or more and has a periodic dependence on reciprocal lattice position. (D.L.C.)

37552 (IS-T-361) ELECTROLYTIC BEHAVIOR OF YTTRIA AND YTTRIA STABILIZED HAFNIA. Schieltz, Jon David (Ames Lab., Iowa). May 1970. Contract W-7405-eng-82. 162p. Dep. CFSTI.

Thesis.

The electric conductivity of undoped yttria was measured over an oxygen partial pressure range of 1 to 10^{-16} atm and a temperature range of 700 to 1000°C. Open circuit emfs were measured over the same temperature interval and oxygen partial pressures of 10^{-6} to 10^{-50} atm. Electric conductivity measurements on yttria–hafnia compositions between 6 and 20 mole percent yttria were performed between 800 and 1000°C and oxygen partial pressures of 1 to 10^{-12} atm to determine the optimum composition for further investigations as a possible electrolyte. Open circuit emf measurements, coulometric titration experiments, and polarization studies were performed to determine the electrolytic behavior of the chosen composition. Results of the investigation are presented in tabular form. (J.R.D.)

37553 (RD/B/N-1649) ANISOTROPIC ELECTROMIGRATION: THE NEARLY FREE ELECTRON MODEL. Hesketh, R. V. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Apr 1970. 7p. Dep. CFSTI (U. S. Sales Only).

The anisotropy observed in electromigration in single crystals of zinc is in excellent agreement with the nearly free electron model of momentum transfer from the electron wind to the diffusing vacancy. (auth) (UK)

37554 (SC-T-70-4024) CALCULATION OF THE BAND STRUCTURE OF ScC AND ScN. Schwarz, K.; Weinberger, P.; Neckel, A. Translated by L. B. Kapp for Sandia Labs., Albuquerque, N. Mex., from Theor. Chim. Acta; 15: 149-64(1969). 26p. Dep. CFSTI.

The energy band structures of ScC and ScN were calculated by the augmented-plane-wave (APW)–method. By using the atomic potentials of Herman and Skillman, the energy eigenvalues for 256 k points in the Brillouin zone were obtained. From these data the density of states and the Fermi energy were derived. The charge distribution within the atomic spheres in the crystal and within the atomic spheres of the free atoms are compared. The eigenfunctions make it possible to calculate the nl-character density, a quantity analogous to the state density. (auth)

37555 MAGNETIC NEUTRON DIFFRACTION. Izyumov, Yurii A.; Ozerov, Ruslan P. New York; Plenum Press (1970). 612p. $37.50.

Translation of Magnitnaya Nietronografiya.

This book offers a comprehensive summary of the current state of theoretical and experimental knowledge on magnetic neutron diffraction. Results are described of investigations on the magnetic structure of rare-earth metals and their compounds, double oxides, electronic structure of magnetic atoms in metals, alloys, and compounds, and spin excitations of magnetics. Modern concepts including ferromagnetism, ferrimagnetism, antiferromagnetism, and Seignette magnetism are discussed. (D.L.C.)

37556 LATTICE DYNAMICS OF HEXAGONAL-TRANSITION METAL BASED ON NEW ELECTRON FORCE MODEL. Sharan, B.; Bajpai, R. P. (Indian Inst. of Tech., New Delhi). J. Phys. Soc. Jap.; 29: 46-9(Jul 1970).

The lattice dynamics of yttrium and titanium have been studied using the authors' new electron-force model described in an earlier paper. Dispersion relations along [0001] and [01$\bar{1}$0] directions have been drawn for both the metals. The present θ-T curves show good agreement with the experimental values. (auth)

37557 LATTICE DYNAMICS OF ZIRCONIUM AND HAFNIUM. Sharan, B.; Bajpai, R. P. (Indian Inst. of Tech., New Delhi). J. Phys. Soc. Jap.; 29: 65-8(Jul 1970).

The lattice dynamics of zirconium and hafnium have been studied using authors' electron force model. Dispersion relations along [0001] and [01$\bar{1}$0] directions are being drawn. The present θ-T curves show good agreement with the experimental values. (auth)

37558 RAMAN SCATTERING BY MAGNONS IN RARE EARTH METALS. Inoue, Michiko (RCA Research Labs., Inc., Tokyo); Moriya, Toru. J. Phys. Soc. Jap.; 29: 117-31(Jul 1970).

A theory of light scattering in a magnetic metal using the spin-dependent electric polarizability is developed and is applied to Raman scattering by magnons in heavy rare earth metals. An important mechanism for one- and two-magnon scatterings arises from the coupling of radiation field with the 4f localized moments via spin-orbit interaction. There are also indirect mechanisms in which electric polarizability of the conduction electrons are modulated by the s-f exchange interaction. Contributions of these mechanisms to the spin-dependent polarizability are estimated. Calculations of the scattering symmetries and intensities are presented for one- and two-magnon processes in systems with ferromagnetic, spiral, and conical spin structures, with application to Tb and Dy, assuming the first mechanism is predominant. In the cases of spiral and conical structures the magnons with wave vectors $\pm k_s$ and $\pm 2k_s$ are excited, where k_s is the wave vector describing the periodicity of the static spin arrangement. (auth)

37559 ELECTRONIC STRUCTURE OF THE METALS OF THE VANADIUM AND CHROMIUM GROUPS. Reale, C. (Centro Ricerche Pellicole Sottili, Milan). Phys. Lett., A; 32: 197-8(9 Jun 1970).

Properties of the conduction electrons in the transition metals of the vanadium and chromium families are deduced from considerations based on the resistivity and optical behavior of vacuum-deposited films. (auth)

37560 WORK FUNCTION OF MOLYBDENUM–RHENIUM ALLOYS. Savitskii, E. M.; Burov, I. V.; Litvak, L. N. (Inst. of Metallurgy, Moscow). Sov. Phys.-Tech. Phys. (Engl. Transl.); 14: 535-7(Oct 1969).

Translated from Zh. Tekh. Fiz.; 39: 713-15(Apr 1969).

Measurements were made under a vacuum of 4×10^{-9} torr of the work function of alloys of the molybdenum–rhenium system in the solid-solution region. It was observed that the work function increases monotonically as the rhenium content is increased up to 50%. (auth)

37561 MAGNETIC PROPERTIES OF URANIUM COMPOUNDS WITH NaCl TYPE STRUCTURE. Adachi, Hirohiko; Imoto, Shosuke (Osaka Univ.). J. Nucl. Sci. Technol. (Tokyo); 7: 322-4 (Jun 1970).

Variations in the magnetic properties of the NaCl-type compounds of U and elements of Groups V and VI are explained theoretically. The theoretical explanations are based on the RKKY theory involving a coupling mechanism between the 3f electrons. The magnetic parameters of the compounds are tabulated, and relations of magnetic parameters to lattice constants are presented. (B.L.M.)

37562 OBSERVATION OF PLASMA RESONANCE AT 790 A IN REFLECTION FROM THIN ZIRCONIUM FILMS. Rudisill, J. E.; Matsui, A.; Weissler, G. L. (Univ. of Southern California, Los Angeles). Contract Nonr 228(27). Opt. Commun.; 2: No. 1, 39-40(May-Jun 1970).

The reflectance of thin Zr films was measured for both parallel and perpendicularly polarized light near the plasma wavelength, and a resonance peak has been observed at 790 Å. (auth)

37563 WORK FUNCTION OF ALLOYS OF IRIDIUM WITH LANTHANUM, CERIUM, PRASEODYMIUM, NEODYMIUM, AND SAMARIUM. Rozhkov, S. E.; Kultashev, O. K.; Dashevskaya, L. I. Radiotekh. Elektron.; 14: 936-7(May 1969). (In Russian).

Results of measurement of the work function of alloys of iridium with small quantities of the rare earth metals in the cerium group are reported. These alloys are two-phase systems, the predominating phase of which is pure iridium, and the second phase the intermetallic compound. The composition of the alloys was controlled by chemical and microstructural analyses. Purities of initial materials were: iridium and lanthanum 99.9%, cerium 99.6%, praseodymium and neodymium 99.7%, and samarium 99.8%. The work function was determined according to total emission current at zero magnetic field and standard temperature according to the Richardson–Dushman equation, with $A = 120.4\ a/cm^2T^2$. Measurements were carried out with vacuum 10^{-8} torr. The work function was stabilized after heating from 1700 to 2000°K for several hours. Further heating at these temperatures during dozens and hundreds of hours did not change the work function. Results show the work function for all of the alloys to be approximately the same (difference ~0.06 eV). Closeness of values of the work function is apparently explained by the fact that these rare earth metals have almost identical electron structure and atomic radii. (tr-auth)

37564 SYMPOSIUM ON ELECTRONIC PHENOMENA IN CHEMISORPTION AND CATALYSIS ON SEMICONDUCTORS, HELD IN MOSCOW, JULY 2–4, 1968. Hauffe, K.; Wolkenstein, Th. (eds.). Berlin; Walter de Gruyter and Co. (1969). 273p. (In German and English). (CONF-680729).

This conference on heterogeneous catalysis was held during the Fourth International Congress on Catalysis. The nineteen papers are arranged into sections dealing with: theory of semiconductor catalysis, mechanism of chemisorption act, mechanism of catalytic act, influence of impurities on catalytic and electronic properties, photo effects in chemisorption and catalysis, and radiation effects on catalytic and electronic properties of semiconductors and insulators. Separate abstracts were prepared for the three papers in the last section. (D.L.C.)

For abstracts of individual papers see: 36309, 37541, and 37542.

37565 MICROWAVE ABSORPTION IN TERBIUM AT 10 GHz. Wagner, T. K.; Stanford, J. L. (Ames Lab., Iowa). Phys. Rev., B; 1: 4488–90(1 Jun 1970).

Recent experimental work on microwave absorption in Tb at 100 GHz indicated that the frozen-lattice model for incorporating the magnetoelastic effects was appropriate. This model, however, predicts that no resonant absorption should occur below ~230 K at 10 GHz, contrary to the observations of Bagguley and Liesegang. Their experiments were repeated, the results essentially agreeing with their results. An alternative interpretation of the observations is offered, which is not only consistent with the frozen-lattice model, but which is believed to be more consistent with present studies on the effects of sample thickness and polarization on the absorption. If the interpretation is correct, some conclusions concerning magneto-elastic effects in Tb that have recently been published will need revision. (auth)

37566 HEAT CAPACITY OF GADOLINIUM NEAR THE CURIE POINT. Lewis, Edwin A. S. (Univ. of Illinois, Urbana). Contract AT(11-1)-1198. Phys. Rev., B; 1: 4368–77(1 Jun 1970).

The dependence of the heat capacity of gadolinium on temperature was observed close to the ferromagnetic Curie point at about 18°C. An "ac" or temperature-modulation method allowed the use of very small single-crystal samples. The heat-capacity peak for the best sample is rounded in a range of $\frac{1}{2}°$ at the Curie point (T_c). Outside this region, good power-law fits are obtained for a range of values of the critical exponents α (above T_c) and α' (below T_c), the choice of which depends on the choice of T_c. The entire set of data, including those in the rounded region, fits an expression derived from a simple macroscopic model of rounding. The T_c specified by this fit makes $\alpha = -0.09 + 0.05$ and $\alpha' = -0.32 \pm 0.05$. Tables of recent theoretical and experimental results are included for comparison. The results on Curie point and rounding are in disagreement with recent conjectures of Cadieu and Douglass for gadolinium. (auth)

37567 MAGNETIC SUSCEPTIBILITY OF VANADIUM AND NIOBIUM HYDRIDES. Aronson, S. (Brooklyn Coll.); Reilly, J. J.; Wiswall, R. H. Jr. J. Less-Common Metals; 21: 439–42 (1970).

Magnetic susceptibility measurements were made on VH_x and NbH_x over the entire range of $0 \leq x \leq 2$. The susceptibility decreases with x, leveling off as $x = 2$ is approached. The temperature dependence is found to be small. On a susceptibility vs electron/atom ratio graph, the VH_x and NbH_x data fall on the curves for V and Nb alloys, respectively, with the $VH_{2.00}$ and $NbH_{2.00}$ data falling close to the minima. Thus, hydrogen donates electrons to the band structure of V and Nb, the contribution being only about half an electron per H atom for $VH_{2.00}$ and $NbH_{2.00}$. (D.L.C.)

37568 MAXIMUM EFFICIENCY OF ENERGY RELEASE IN SPHERICAL COLLAPSE. Leibovitz, C.; Israel, W. (Univ. of Alberta, Edmonton). Phys. Rev., D; 1: 3226–9(15 Jun 1970).

The question of the maximum amount of energy which can be radiated by a collapsing spherical star is reexamined. On Newtonian theory, gravitational energy is negative and unbounded below, so that unlimited amounts of energy can be released. It is shown that, in the relativistic collapse of a star with non-negative energy density, self-closure always takes place before the star can release 100% of its initially positive mass energy. Moreover, under physically reasonable restrictions on the pressure, the 100% upper limit can be approached only if the star happens to pass through a very special and improbable momentarily static configuration first considered by Zel'dovich. It is concluded that for normal spherical collapse the efficiency of energy release must be low. (auth)

Moessbauer Effects and NMR

Refer also to abstracts 36598, 36601, and 36666.

37569 DYNAMIC POLARISATION OF NUCLEI BY SATURATION OF FORBIDDEN TRANSITIONS. Sukheeja, B. D. (Regional Engineering Coll., Kurukshetra, India); Narchal, M. L. J. Phys. Soc. Jap.; 29: 90–3(Jul 1970).

The degree of dynamic nuclear polarisation in a multilevel electron–nuclear coupled spin system is computed in the high-temperature limit when the first-order forbidden transitions are saturated by an appropriate microwave field. Both the cases of either the hyperfine or the nuclear Zeeman interaction dominating over the other are discussed. In the latter case, the enhancement of nuclear magnetic resonance is also calculated and compared with the available experimental data. (auth)

37570 LINEWIDTHS IN HIGH-RESOLUTION NMR SPECTRA. HOMOGENEOUS BROADENING DUE TO INTERMOLECULAR RELAXATION. Sykora, Stanislav (Istituto di Chimica Industriale del Politecnico, Milan). J. Chem. Phys.; 52: 5949–51(1 Jun 1970).

The effects connected with the intermolecular relaxation in the coupled nuclear systems are studied theoretically. It was shown that, because of the general properties of nuclear-spin systems, the number of parameters necessary to describe the relaxation process is reduced substantially. Moreover, the structure of nuclear system and relaxation process parameters is to a far extent separated. This fact enables one to draw quite detailed conclusions on the energy-level widths even without any specification of the type of intermolecular relaxation process. (auth)

37571 NUCLEAR MAGNETIC RESONANCE IN $Be_{22}Re$ AND $Be_{22}Tc$. Bernasson, M.; Descouts, P.; Styles, G. A. (Univ., Geneva). Helv. Phys. Acta; 43: 393–401(1 Jul 1970).

The NMR Knight shifts K and linewidths ΔH of the ^9Be, ^{185}Re, ^{187}Re, and ^{99}Tc resonances were measured in the intermetallic compounds $Be_{22}Re$ and $Be_{22}Tc$ at three different magnetic field strengths. Both K and ΔH were determined at 300°K, 77°K, and 4.2°K and were found to be independent of temperature. The linewidths of the ^9Be resonance in both compounds and of the ^{185}Re and ^{187}Re resonances in $Be_{22}Re$ exhibit a field-dependence shown to be due to second-order quadrupole effects. The values of the Knight shift of ^9Be ($K = -0.0027\%$), close to that measured in pure Be, together with those of ^{185}Re ($K = -0.880\%$) and of ^{99}Tc ($K = -0.536\%$) appear to indicate localization of the d-electron wavefunctions near the transition metal ions. (auth)

37572 KONDO EFFECT IN Mo(Fe) ALLOYS FROM MOESSBAUER-EFFECT MEASUREMENTS. Maley, M. P.; Taylor, R. D. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., B; 1: 4213–23(1 Jun 1970).

An extension of earlier Moessbauer-effect studies of the magnetic behavior of very dilute Fe impurities in Mo is reported. A connection is made between the well-known resistance minimum in this alloy and evidence for the transition to a nonmagnetic state at low temperatures. Consistent with current theories, based upon the s–d exchange model, a value of the characteristic Kondo temperature, T_K^{fd}, of (0.25 ± 0.05)°K is measured. Comparison with a recent spin-fluctuation model indicates $T_K^{fd} \simeq (1.0 \pm 0.1)$°K. A field-dependent saturation hyperfine field is observed and determined to fit a recent theory by Ishii, which predicts an asymptotic approach of the low-temperature induced moment, with applied field, to its high-temperature value. The high-temperature moment is determined to be 2.6 μ_B. Implications for various physical models are discussed. (auth)

37573 NUCLEAR QUADRUPOLE COUPLING AND CRYSTAL-FIELD EFFECTS IN THE CUBIC INTERMETALLIC COMPOUNDS $ErAl_3$, $TmAl_3$, AND $YbAl_3$. de Wijn, H. W. (Univ., Amsterdam); van Diepen, A. M.; Buschow, K. H. J. Phys. Rev., B; 1: 4203–8 (1 Jun 1970).

The presence of a large nuclear quadrupole coupling of the Al nucleus, as measured with NMR, in the cubic rare earth–aluminum intermetallic compounds β–$ErAl_3$, $TmAl_3$, and $YbAl_3$ indicates that the net charges at the rare earth and aluminum sites differ by as much as 3 to 4 unit charges. Data on the magnetic susceptibility and this result have been used to analyze crystal-field effects in $TmAl_3$. The ground state appears to be a nonmagnetic doublet Γ_3, the next higher level being the triplet $\Gamma_5^{(1)}$ at a distance of 45°K. In addition, from the Knight shift, exchange constants between conduction electrons and 4f electrons have been derived to be $\mathcal{J}_{sf} = -0.24$ eV. (auth)

37574 NUCLEAR MAGNETIC RESONANCE AND KNIGHT SHIFT OF CADMIUM IN DILUTE ALLOYS. Slocum, Robert Richard. Williamsburg, Va.; Coll. of William and Mary (1969). 73p.

Thesis.

The nuclear magnetic resonance of ^{113}Cd has been investigated in dilute binary alloys with indium, silver, and magnesium solutes

in an effort to isolate the parameters controlling the anomalous temperature dependence of the cadmium Knight shift. Changes in the Knight shift produced by alloying have been measured at 4.2°K, 78°K, 300°K, and 423°K, employing a static magnetic field of 12 kilogauss. All observed changes in the isotropic Knight shift are small, and may be accounted for in terms of Friedel oscillations or the rigid band model. From changes in line shapes, it is concluded that alloying magnesium decreases the anisotropic Knight shift of cadmium. It is concluded that changes in the c/a ratio, changes in the energy gap at points K in the Brillouin zone, and changes in the diamagnetic susceptibility may be ruled out as major sources of the thermal behavior of the isotropic Knight shift in pure cadmium. The data appear to be in agreement with a recent pseudopotential calculation which attributes the temperature dependence of the isotropic shift in cadmium primarily to the pronounced d-character in the pseudopotential and the effects of lattice vibrations. (Diss. Abstr. Int., B)

37575 PROTON SPIN–LATTICE RELAXATION IN PARAMAGNETIC SOLID $UO_2.xH_2O$. Sharp, A. R. (Univ. of Waterloo, Ont.); Pintar, M. M.; Komac, M. J. Chem. Phys.; 52: 6323–4 (15 Jun 1970).

Proton spin–lattice relaxation times of four $UO_2 \cdot xH_2O$ hydrates–hydroxides were measured at 23 Mc/sec in the temperature range from +50 to −140°C. The observed relaxation rate is explained as being due to reorienting water molecules and to S_2 $(U^{4+})I^+$ (H) coupling. (auth)

Theoretical Physics

Refer also to abstracts 37407 and 37872.

37576 (BMBW-FBK-70-7) CALCULATION OF ABSOLUTE TRANSITION PROBABILITIES IN THE SPECTRA OF THE HEAVY RARE GASES. Meiners, H. (Technische Hochschule, Hanover (West Germany). Institut fuer Plasmaphysik). Apr 1970. 66p. (In German). Dep. CFSTI (U. S. Sales Only).

The absolute scaling factor σ^2 was calculated by use of self-consistent-field wave functions for a number of transitions of the heavy rare gases. The radial wave functions were computed by use of the Hartree–Fock–Slater approximation as well as by use of the exchange potential proposed by Kohn and Sham. The results are compared to the corresponding σ^2 obtained in Coulomb approximation from the tables of Bates and Damgaard. For several transitions, large discrepancies are observed. For some Ar I transitions, the results of the different theoretical approximations are discussed in comparison to the experimental A_{nm} values. (auth)

37577 (CTO–716) INTEGRATION IN FUNCTION SPACE AND ITS APPLICATION IN QUANTUM PHYSICS. Gel'fand, I. M.; Yaglom, A. M. Translated by L. C. Ronson for Culham Lab., Abingdon, Eng., from Usp. Mat. Nauk; 11: 77–114 (Jan–Feb 1956). 57p. (CONF-550501–1). Dep. CFSTI (U. S. Sales Only).

From 3rd All Union Conference on Probability Theory and Applications, Leningrad, USSR.

At present methods of the theory of measure and integration in function space are used extensively only in the theory of random processes. However, as is already evident today, these methods may be of considerable importance in a number of other departments of mathematics and theoretical physics, primarily in the theory of differential equations, quantum physics and hydrodynamics. An attempt is made briefly to discuss the application of these methods in quantum physics. (auth)

37578 (JINR–E2–5067) SYMMETRIES IN THE CLASSICAL THREE-BODY PROBLEM. Nyiri, J.; Smorodinskii, Ya. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1970. 29p. Dep. CFSTI (U. S. Sales Only).

Classical Lagrangian and Euler equations of the three-body problem are given in different coordinate systems, including Boltzmann quasi coordinates. This paper supplements quantum mechanical consideration, given before. (auth)

37579 (LA–4394) ELEMENTARY REVIEW OF ANGULAR MOMENTUM. Keaton, P. W. Jr. (Los Alamos Scientific Lab., N. Mex.). Feb 1970. Contract W-7405-eng-36. 53p. Dep. CFSTI.

A set of notes is presented to refresh the reader on basic concepts of angular momentum in quantum mechanics. The purpose is to review background information necessary for a study of polarization phenomena in nuclear interactions. Tedious calculations are carried through as an illustration of general cases. The treatment is similar to that of M. E. Rose and A. R. Edmonds. The appendixes are self-contained so that they may be used conveniently as references. (auth)

37580 (LYCEN–7022) A NEW MATHEMATICAL METHOD FOR A COMPUTER PROGRAM FOR THE SOLUTION OF LAPLACE'S EQUATION. Couchoud, S. (Lyon Univ. (France). Institut de Physique Nucleaire). Apr 1970. 6p. Dep. CFSTI (U. S. Sales Only).

A method is proposed for solving Laplace's equation with prescribed boundary conditions. By means of this method the potential and the field at any point inside the boundary can be found to any required accuracy. (France)

37581 (NYO–3406–17) DISCUSSION OF EXPERIMENTAL TESTS OF HIDDEN VARIABLE THEORY, WITH APPLICATION TO AN INTERFERENCE EXPERIMENT. Nelson, M. R.; Warrington, D. M.; Reynolds, Geo. T. (Princeton Univ., N. J. Elementary Particles Lab.). 5 Dec 1969. Contract AT(30-1)-3406. 18p. Dep. CFSTI.

Two quantum mechanical observables that commute with one another are considered. Consideration of correlated observables led Einstein et al. (Phys. Rev., 47: 777(1935)) to question the measurement assumption. Some examples of these observables and their various quantities are discussed. (M.O.W.)

37582 (NYO–3829–50) CLASSICAL ELECTRODYNAMICS IN TWO DIMENSIONS: EXACT SOLUTION. Bialynicki-Birula, I. (Pittsburgh Univ., Pa. Dept. of Physics). May 1970. Contract AT(30-1)-3829. 11p. Dep. CFSTI.

Classical electrodynamics of N charged point-like particles, moving in the space–time of two dimensions is studied. The exact solution of this model is found and its properties connected with the Poincaré group in two dimensions are described. In the case of N = 2, the solution reduces to a model of relativistic classical mechanics discovered by D. G. Currie and T. F. Jordan and by A. N. Beard and R. Fong. Nonlinear generalizations of the model are also discussed. (auth)

37583 (SC–RR–70–28) IMPROVEMENTS IN THE CHART D RADIATION-HYDRODYNAMIC CODE I: ANALYTIC EQUATIONS OF STATE. Thompson, Samuel L. (Sandia Labs., Albuquerque, N. Mex.). Jan 1970. 121p. Dep. CFSTI.

A set of equation-of-state subroutines for in-line hydrodynamic code use is described. The information generated is thermodynamically complete and self-consistent. Any combination of elements may be included. The range of validity is large: temperatures from 100°K to 10^8°K and nearly all important densities. Solids, liquids, vapors, plasmas, and phase mixtures are treated. Simple solid–solid phase transitions are included. An approximate value of the Rosseland mean opacity is calculated. The routines were written for the CHART D radiation diffusion hydrodynamics code but may easily be included in other codes. With minimal effort an equation of state of any substance can be generated. (auth)

37584 APPROACH TO HAMILTONIZATION AND QUANTIZATION OF RADIATIVELY DAMPED SYSTEMS. Sutcliffe, William George. Newark, Del.; Univ. of Delaware (1969). 93p.

Thesis.

A general program for proceeding from Newton's second law, including nonconservative forces, to a quantum-mechanical equation of motion is proposed. A method of handling equations of motion containing higher-order derivatives, viz., order reduction, is demonstrated for the radiation damping force. The Lorentz-covariance requirements of the order reduced force of radiation damping are obtained. The construction of constants of the motion that reduce to energy and angular momentum in the absence of damping is illustrated. These constants appear to be multivalued for nonconservative systems. A procedure to restate equations of motion as a canonical action principle is demonstrated. An unambiguous quantization process and the definition of the Hamiltonian operator in terms of the classical Hamiltonian function is presented. Because of the nonuniqueness of the constants of the motion, a definitive energy correction due to radiation damping, as illustrated in this work, remains to be accomplished. (Diss. Abstr. Int., B)

37585 SYNCHROTRON MOTION WITH RADIATION DAMPING. Sen Gupta, N. D. (Tata Inst. of Fundamental Research, Bombay). Phys. Lett.; 32A: 103–4 (15 Jun 1970).

The longitudinal velocity of the relativistic motion with radiation reaction is shown to be constant. The radiation frequency is $(eB/mc)\{1 + O(e^3B/m^3c^4)\}$ in the system with zero longitudinal velocity. The particle energy in this system is obtained. (auth)

37586 FLUX EQUILIBRIA IN QUANTUM SYSTEMS FAR AWAY FROM THERMAL EQUILIBRIUM. Graham, R.; Haken, H.; Weidlich, W. (Univ., Stuttgart, Ger.). Phys. Lett.; 32A: 129–30 (15 Jun 1970).

Quasi-probability functions make it possible to study flux equilibria and phase transitions in quantum systems far from thermal equilibrium using concepts of classical statistical mechanics. (auth)

37587 ELECTROMAGNETIC MOMENTUM OF CHARGED PARTICLES. Cohn, Jack (Univ. of Oklahoma, Norman). Amer. J. Phys.; 38: 502-6(Apr 1970).

The current definition of the comomentum associated with a moving charge is discussed, and it is shown to be unsuitable for a charge undergoing nonuniform motion. An alternative definition is then proposed for a charged particle of vanishingly small size, and it is demonstrated that this definition is satisfactory for a charge in arbitrary motion. (auth)

37588 SCATTERING AMPLITUDES WITH REARRANGEMENT AT LOW ENERGIES. Brodskii, A. M.; Levich, V. G.; Tolmachev, V. V. (Inst. of Electrochemistry, Moscow). Dokl. Akad. Nauk SSSR; 182: 1036-9(11 Oct 1968). (In Russian).

Expressions for amplitude processes with rearrangement in the case in which the kinetic energy of colliding fragments is small in comparison to the high-level excitation energy were derived, using the general quantum-mechanical theory of multiple scattering. The examined case may be applied for various inelastic atom–molecule collisions, chemical reactions, and low-energy nuclear reactions. The steady-state problem of scattering process with rearrangement (reaction) at energy equal to E is presented symbolically by the scheme of (1,2) + 3 → 1 + (2,3) where 1, 2, and 3 are complex fragments in bound states. In case of identical fragments, the reaction channels and asymptotic functions are generalized by ordinary methods. This mathematical analysis permits one to express the probability of reactions by asymptotic state characteristics and elastic scattering without any obvious assignment of interaction potentials. (R.V.J.)

37589 CLASSICAL FUNCTIONS CORRESPONDING TO QUANTUM OPERATORS. Vinson, J. F. (Institut Henri Poincare, Paris). Ann. Inst. Henri Poincare, Sect. A; 12: 255-61 (1970). (In French).

An attempt was made earlier to state a general rule of association between the quantum observables and the classical functions that would meet the unity criterion and would produce, as a consequence, a real classical function that would correspond to every Hermitian operator. It is shown that this rule is a necessary consequence of the quantum theory. (France)

37590 PROBLEMS OF MODERN MATHEMATICAL PHYSICS. Destouches, Jean-Louis; Aeschlimann, Florence. Paris; Gauthier-Villars (1969). 236p. (In French).

A hundred commonly encountered problems of mathematical physics (quantum mechanics, statistical quantum mechanics, wave mechanics) for graduate Students are included. They were set during last years at various Certificate examinations of the Faculty of sciences, Paris at the "Diplome d'Etudes Approfondies de Statistiques" (mathematical physics option) as well as at some internal examinations of the "Ecole Centrale des arts et manufactures." The detailed solutions of 28 problems chosen from among the most instructive ones are also included. (France)

37591 NONRELATIVISTIC PROOF OF THE SPIN-STATISTICS THEOREM. Donth, E. Phys. Lett., A; 32: 209-10 (9 Jun 1970).

Using a continuous transform equivalent to identical particle interchange, a proof of the spin-statistics theorem is given for which only nonrelativistic arguments are necessary. (auth)

37592 REASSESSMENT OF A DETERMINATION OF e/h, USING MACROSCOPIC QUANTUM PHASE COHERENCE IN SUPERCONDUCTORS. Denenstein, A. (Univ. of Pennsylvania, Philadelphia); Finnegan, T. F.; Langenberg, D. N.; Parker, W. H.; Taylor, B. N. Phys. Rev., B; 1: 4500-3(1 Jun 1970).

The discovery of a possible systematic error in the Parker–Langenberg–Denenstein–Taylor determination of e/h, using the ac Josephson effect, has led to a remeasurement together with a reassessment of the original data. A number of factors contributing to the experimental uncertainty were carefully reexamined. The result of the remeasurement is in good agreement with the result reported by Parker et al. A comparison of the present result with the result of a reanalysis of the data of Parker et al. indicates that the suspected systematic error, if present in the earlier experiment, is almost certainly less than 2 parts per million. (auth)

37593 EQUATION OF STATE OF THE PERFECT FERMI GAS. Bauer, W. (Brown Univ., Providence); Hilf, E. Phys. Lett., A; 32: 189-90(9 Jun 1970).

The equation of state of the perfect relativistic Fermi gas is implicitly given by the three Fermi–Jüttner integrals for the pressure p, the kinetic energy density u, and the number density n, respectively. A quick computer program is presented that calculates these integrals with a precision of 10^{-7} for the whole space of states, as necessary for astrophysical calculations on hot neutron or hadron stars. (auth)

37594 HYDRODYNAMIC MODEL OF QUANTUM MECHANICS. Wilhelm, H. E. (Colorado State Univ., Fort Collins). Phys. Rev., D; 1: 2278-85(15 Apr 1970).

An analysis of typical microphysical systems is presented in the hydrodynamic formulation of quantum mechanics. The emphasis is on the physical peculiarities appearing in the hydrodynamic picture, and on the mathematical treatment of the nonlinear quantum-hydrodynamic field equations. Further, quantum-hydrodynamic uncertainty relations are derived, which relate the minimum uncertainty products to the interior quantum stresses. (auth)

37595 RADIATION OF A CHARGE IN A MAGNETIC FIELD. Mychelkin, E. G. (Astrophysics Inst., Alma-Ata, USSR). Tr. Astrofiz. Inst., Akad. Nauk Kaz. SSR; 14: 100-12(Jan 1970). (In Russian).

The paper deals with the transformational properties of various characteristics of the field of emission of relativistic particles and methods of representing the corresponding electromagnetic energy fluxes. On this basis, a detailed analysis is given of various strict solutions of a problem important in astrophysical applications—that of the radiation from a particle moving along a cylindrical spiral in a magnetic field. (auth)

37596 TRANSVERSE ELECTRICAL CONDUCTIVITY OF A RELATIVISTIC GAS IN AN INTENSE MAGNETIC FIELD. Canuto, V.; Chiuderi, C. (Goddard Space Flight Center, New York). Phys. Rev., D; 1: 2219-26(15 Apr 1970).

The transverse electrical conductivity is computed for a system of degenerate relativistic electrons in a strong magnetic field $H \approx 10^{10} - 10^{13}$ G. As suggested by pulsar models, such fields exist in nature in collapsed bodies, like neutron stars. The present computation is valid in the outer regions of the star where the scatterers are not degenerate, while the electrons are taken to be at zero temperature. The scattering mechanism is assumed to be the electron–ion Coulomb scattering. Numerical values of the transverse conductivity are given in the range $10^9 \leq H \leq 10^{13}$ G, and a comparison is made with the longitudinal and zero-field conductivities. It is found that for densities $10^7 \leq \rho \leq 5 \times 10^7$, $\sigma_{\parallel} \approx 20\sigma_0$ and $\sigma_0 \approx 3\sigma_{\perp}$. As the density increases, both $\sigma_{\perp}$ and $\sigma_{\parallel}$ tend to σ_0. (auth)

37597 THE DIRAC BISPINOR FORM OF MAXWELL'S EQUATIONS AND THE ANOMALOUS HYPERFINE STRUCTURE OF RELATIVISTIC HYDROGEN. Leiter, D. (Boston Coll., Chestnut Hill, Mass.). Nuovo Cim.; 68B: 53-63(11 Jul 1970).

It is shown that, in addition to the usual covariant tensor form of Maxwell's equations, a more general, manifestly covariant, Dirac bispinor form of them exists. A study of the Lagrangian formulation of electrodynamics, utilizing this more general bispinor electromagnetic-field structure, is conducted. It is found that, in addition to the conventional Lorentz force interaction, a new electromagnetic "spinor-torque" interaction, related to the bispinor structure, is generated. The effect that Dirac bispinor electrodynamics has on the spectrum of relativistic hydrogen is studied and it is shown that the new "spinor-torque" interaction will contribute an extra anomalous hyperfine structure term, in addition to that generated by proton spin structure and quantum electrodynamic effects. Estimates of the value of the coupling constant associated with the "spinor-torque" interaction, which has the dimensions of a length, are given. (auth)

37598 EQUIVALENCE CLASSES OF MINIMUM UNCERTAINTY PACKETS. Stoler, David (Polytechnic Inst. of Brooklyn). Phys. Rev., D; 1: 3217-19(15 Jun 1970).

It is shown that all the minimum uncertainty packets are unitarily equivalent to the coherent states and that coherence is in fact stationary minimality. (auth)

PHYSICS (HIGH ENERGY)

Particle Interactions and Properties (Experimental)

Refer also to abstracts 37662, 37663, 37666, 37674, 37675, and 38322.

Electromagnetic

37599 (LAL-1231) THE ANNIHILATION REACTION $e^+e^- \rightarrow \phi$ IN THE COLLISION RING AT ORSAY. Richard, Francois (Paris Univ., Orsay (France). Faculte des Sciences). May 1970. 105p. (In French). Dep. CFSTI (U. S. Sales Only).

Thesis.

The partial decay width of the ϕ meson is found from the interaction $e^+ + e^- \rightarrow \phi$ using the Orsay storage ring. The decays $\phi \rightarrow K^0 + \bar{K}^0$ and $\phi \rightarrow 3\pi$ are studied using scintillation counters and spark chambers. This experiment gives the cross sections for $ee \rightarrow \phi \rightarrow K^0\bar{K}^0$ and $ee \rightarrow \phi \rightarrow 3\pi$ and the width of ϕ. From these results the first precise determination of the partial width of $\phi \rightarrow e^+ + e^-$ is found to be 1.45 ± 0.27 keV. (J.F.P.)

37600 (LAL-1233) STUDY OF ϕ MESON BY e^+e^- ANNIHILATION INTO CHARGED K MESONS AND TESTS OF VECTOR DOMINANCE MODELS. Bizot, J. C.; Buon, J.; Chatelus, Y.; (and others) (Paris Univ., Orsay (France). Laboratoire de l'Accelerateur Lineaire). Jun 1970. 17p. Dep. CFSTI (U. S. Sales Only).

The $e^+e^- \rightarrow \phi$ reaction was measured by its K^+K^- decay mode. Using previous results on $K^0\bar{K}^0$ and the 3π decay mode of the ϕ mesons, $\Gamma_\phi \rightarrow e^+e^-$ is computed, and then the whole Orsay results are compared to theoretical predictions. (auth)

37601 (LAL-1234) PRODUCTION OF VECTOR MESONS BY e^+e^- ANNIHILATION. Perez-Y-Jorba, J. (Paris Univ., Orsay (France). Laboratoire de l'Accelerateur Lineaire). Jun 1970. 41p. Dep. CFSTI (U. S. Sales Only).

A review of the $e^+ + e^-$ annihilation in storage rings with vector meson production is presented. This review covers the description of experimental devices, data processing, results, and theory including tests of vector dominance, sum rules, coupling constants, and mixing angles. (J.F.P.)

37602 (LNF-69/77) STUDY OF THE $\pi\pi$ INTERACTION AND TESTS OF CHARGE CONJUGATION INVARIANCE IN THE PROCESS $e^+e^- \rightarrow \pi^+\pi^-\gamma$ (PRELIMINARY PROPOSAL). Note No. 459. Stella, B. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). 5 Dec 1969. 17p. (In Italian). Dep. CFSTI (U. S. Sales Only).

Appealing to the situation and possible experiments concerning the scalar-isoscalar mesons ($J^P\ I^C = 0^+0^+$, σ, $\epsilon \circ \epsilon S^*$) and the charge conjugation invariance, the interest of a colliding beam experiment on the process $e^+e^- \rightarrow \pi^+\pi^-\gamma$ both in studying $\pi\pi$ interaction and in the search of C-violating effects is discussed. (auth)

37603 PRODUCTION ASYMMETRY IN $\gamma + n \rightarrow \pi^- + p$ PROCESS WITH POLARIZED PHOTONS. Kondo, Kunitaka, (Tokyo Univ.); Nishikawa, Tetsuji; Suzuki, Toshio; Takikawa, Koji; Yoshida, Hajime; Kimura, Yoshitaka; Kobayashi, Masaaki. J. Phys. Soc. Jap.; 29: 13-29(Jul 1970).

The production asymmetry in the reaction $\gamma + n \rightarrow \pi^- + p$ is measured at 90° in the center-of-mass system and at five photon energies from 357 to 555 MeV. Linearly polarized photons are obtained by means of the coherent bremsstrahlung process from a silicon single crystal. Negative pions and recoiling protons from a liquid-deuterium target are detected simultaneously so that events originated from neutrons almost at rest in the deuterons are selected. The asymmetry data are compared with the dispersion-relation calculation of Berends, Donnachie, and Weaver, and with that of Schmidt et al. It is shown that the contribution from the Roper P_{11} (1470) resonance is small in the pion photoproduction process. (auth)

37604 NEUTRAL DECAY MODES OF THE η^0 MESON. Devons, S. (Columbia Univ., New York); Grunhaus, J.; Kozlowski, T.; Nemethy, P.; Shapiro, S.; Horwitz, N.; Kalogeropoulos, T.; Skelly, J.; Smith, R.; Uto, H. Phys. Rev., D; 1: 1936-45(1 Apr 1970).

The branching ratios of the decay of the η^0 meson into neutral products were measured. The η^0 is produced in the reaction $\pi^- + p \rightarrow \eta^0 + n$, and the decay products are observed as γ rays by a system of optical spark chambers and counters in nearly 4π geometry. Emphasis was placed on examining evidence for the decay mode $\eta^0 \rightarrow \pi^0\gamma\gamma$ ($\rightarrow 4\gamma$). Measurement of the neutron time of flight in the production process, together with detailed measurement and kinematical analysis of the pictures showing four γ rays, allows each event to be tested for consistency with such a decay mode, and also for the "background" process $\pi^- + p \rightarrow 2\pi^0 + n$. From what is essentially a comparison of the observed rates for these processes, the upper limit for $(\eta^0 \rightarrow \pi^0\gamma\gamma)/(\eta^0 \rightarrow$ all neutrals) ≤7% (90% confidence level) is obtained, a result which is relatively insensitive to estimates of the efficiency of the detecting system. $(\eta^0 \rightarrow 3\pi^0)/(\eta^0 \rightarrow 2\gamma) = 0.75 \pm 0.09$ is also obtained. (auth)

37605 MEASUREMENT OF ELECTROPRODUCTION OF MUON PAIRS. Earles, D. R.; Chase, R. C.; Faissler, W. L.; (and others) (Northwestern Univ., Boston). Phys. Rev. Lett.; 25: 129-33(13 Jul 1970).

An experiment on electroproduction of muon pairs with invariant masses between 400 and 900 MeV is reported. The experiment, interpreted as a test of the timelike photon propagator, shows agreement with QED. Photon propagator modifications representing (+) metric and (-) metric heavy photons are limited to masses $\Lambda > 1260$ and $\Lambda > 750$ MeV, respectively (15 times the mass limits of positronium experiments). A model used to calculate ρ-QED interference yields a best ρ-QED phase angle of 16° ± 22°. (auth)

37606 SEARCH FOR MAGNETIC MONOPOLES IN THE MOON. Schatten, Kenneth H. (Goddard Space Flight Center, Greenbelt, Md.). Phys. Rev., D; 1: 2245-51(15 Apr 1970).

The effects of a possible magnetic charge of the moon upon the magnetic field in the lunar vicinity have been analyzed. Magnetic field observations obtained by the GSFC magnetometer aboard Explorer 35 have been studied to search for these effects. Using these observations, it is possible to obtain a measure of the net difference between the number of northern and southern monopoles within the moon which are of opposite sign. The search has resulted in negative findings and places an approximate upper limit on the average difference in the number of monopoles within the moon at 1.6×10^{-7} cm^{-3} or 7×10^{-32} per nucleon. (auth)

37607 ELASTIC ELECTRON-PROTON SCATTERING CROSS SECTIONS MEASURED BY A COINCIDENCE TECHNIQUE. Goitein, M.; Budnitz, R. J.; Carroll, L.; Chen, J. R.; Dunning, J. R. Jr.; Hanson, K.; Imrie, D. C.; Mistretta, C.; Wilson, Richard (Harvard Univ., Cambridge, Mass.). Phys. Rev., D; 1: 2449-76(1 May 1970).

Elastic electron-proton scattering cross sections were measured in the range of four-momentum transfers from 7 F^{-2}[0.27(GeV/c)^2] to 150 F^{-2}[5.84(GeV/c)^2] and at scattered electron angles of between 20° and 34° in the laboratory. The estimated errors in the cross sections range from ±2.1% at the lowest momentum transfer to ±9.6% at the highest. Both the scattered electron and the recoil proton were detected, resulting in an overdetermination of the kinematics. When the constraint of a coincident proton is removed, there is no significant change in the estimated cross sections. (auth)

37608 ELECTROPRODUCTION OF PIONS ON PROTONS. Titov, Yu. I.; Severin, N. F.; Afanas'ev, N. G.; Akhmerov, R. V.; Byvalin, S. A.; Stepula, E. V.; Smelov, E. M.; Yaroshevskii, L. D. (Physical-Technical Inst., Kharkov). Yadern. Fiz.; 11: 946-7(May 1970). (In Russian).

Results are given of the first studies of electroproduction of pions on protons on the 2 GeV accelerator of the Physico-Technical Institute of the Ukrainian Academy of Sciences. Spectra of elastic and inelastic electron scattering at 1000 and 1170 MeV initial energy under different angles are given. The data are compared with the calculations within the relativistic SU(6) symmetry scheme. (auth)

37609 HIGH ENERGY MULTIPLE COULOMB SCATTERING IN NUCLEAR EMULSIONS. Montret, J. C.; Coupat, B.; Vazeille, F.; Avan, L. (Univ., Clermont-Ferrand, France). J. Phys. (Paris); 31: 163-71(Feb-Mar 1970). (In French).

In the study of multiple Coulomb scattering for high energies and large cells there arises the problem of the validity of the K scattering factor introduced theoretically by Voyvodic and Pickup. K 5 nuclear emulsions irradiated in muon beams at 6 and 12 GeV are particularly suited for such a study. One has been able to determine for the first time a complete set of K values for cell length between 1 and 15 mm. Moreover, various methods of measurements using the multiple Coulomb scattering technique are presented. (France)

Weak

37610 (CERN-Trans-69-26) POSSIBILITIES OF PERFORMING NEUTRINO EXPERIMENTS WITH THE IHEP ACCELERATOR. Bolotov, V. N.; Gerdyukov, L. N.; Gershtein, S. S.; (and

others) (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov. Institut Fiziki Vysokikh Energii). Translated by A. Golovanoff (CERN, Geneva), from report IFVE-SEF/STF/OP/SKU-68-56K. 214p. (In French). Dep. CFSTI.

The discussion of the possibilities of neutrino experiments using the IHEP accelerator covers neutrino spectra with the IHEP accelerator and principal elements of the neutrino channel, proposed detectors for these experiments, various possibilities for physical study of the neutrino, and the possibilities of studies with the muon. (J.F.P.)

37611 (COO-1428-211) NEUTRINO INTERACTIONS IN THE DEUTERIUM-NEON 14 FOOT DOUBLE BUBBLE CHAMBER. (Purdue Univ., Lafayette, Ind. Dept. of Physics). 10 Jun 1970. 11p. Dep. CFSTI.

We propose to study the interactions of high energy neutrinos in the 14 foot bubble chamber. The target chamber to be filled with deuterium and the surrounding region filled with nearly pure neon. An exposure of one million pictures is requested, in order to map out the s and t dependences of the basic interactions in which neutrinos participate. (auth)

37612 (LAL-1232) STUDY OF THE DECAYS $K_L^0 \rightarrow \pi^0\pi^0\pi^0$ AND $K^+ \rightarrow \pi^+\pi^0\pi^0$. Heusse, Ph. (Paris Univ., Orsay (France). Faculte des Sciences). Jun 1970. 149p. (In French). Dep. CFSTI (U. S. Sales Only).

Thesis.

A study is made of the energy dependence of the matrix element for $K_L^0 \rightarrow 3\pi^0$ and $K^+ \rightarrow \pi^+ + 2\pi^0$ decay modes. A heavy-liquid bubble chamber is used for this study. The experimental conditions and methods of analysis are discussed, and the theoretical interpretation and analysis of these results are given. (J.F.P.)

37613 (NAL-44) UPPER LIMIT FOR MAGNETIC MONOPOLE PRODUCTION BY NEUTRINOS. Carrigan, R. A. Jr.; Nezrick, F. A. (National Accelerator Lab., Batavia, Ill.). Jun 1970. 13p. Dep. CFSTI.

Existing magnetic monopole searches are re-evaluated in terms of monopole production by cosmic-ray neutrinos. The upper limit for the cross section for monopole production inside the best ocean-bed sample is $\sigma_D \leq 1.0 \times 10^{-39}\ E_T^2\ cm^2$. An even lower limit of $\sigma_C \leq 3.0 \times 10^{-42}\ E_T^2\ cm^2$ is established if the monopoles are collected on the sample from surrounding ocean water. (auth)

37614 SPIN DEPENDENCE OF AN WEAK INTERACTION IN DECAY OF HYPERNUCLEI. Rao, N. K. (Tata Inst. of Fundamental Research, Bombay); Swami, M. S.; Gurtu, A.; Singh, M. B. Proc. Indian Acad. Sci., Sect. A.; 71: 101-10(Mar 1970).

From an analysis of 468 hypernuclei (HFs) with ranges > 120 μm, the nonmesic to π^--mesic ratio (Q^-) for $^4_\Lambda$He and $^5_\Lambda$He HFs was found to be 1.37 ± 0.17 and 1.58 ± 0.20 respectively. These data, together with results on $^4_\Lambda$He and heavy hypernuclei, were used to deduce spin dependences for Λn and Λp weak interactions in decay of hypernuclei. It is found that the rates for triplet and singlet interactions between Λ and neutron are $22\Gamma_\Lambda$ and $11\Gamma_\Lambda$ and for Λ and proton are $8.2\Gamma_\Lambda$ and $5.5\Gamma_\Lambda$ respectively, where Γ_Λ is the decay rate of Λ. The total decay rates for $^4_\Lambda$He and $^5_\Lambda$He are $1.28\Gamma_\Lambda$ and $0.99\Gamma_\Lambda$ and the nonmesic decay rates are $0.17\Gamma_\Lambda$ and $0.51\Gamma_\Lambda$ respectively. (auth)

37615 EXPERIMENTAL SEARCH FOR CP-VIOLATING DECAY $K_S \rightarrow \pi^+\pi^-\pi^0$. Webber, Bryan R.; Solmitz, Frank T., Crawford, Frank S. Jr.; Alston-Garnjost, Margaret (Univ. of California, Berkeley). Phys. Rev., D; 1: 1967-71(1 Apr 1970).

The time distribution of the neutral K decays was studied in 53 hydrogen bubble-chamber events of the type $K^-p \rightarrow \bar{K}^0n$, neutral $K \rightarrow \pi^+\pi^-\pi^0$. In 20 of these events, the neutral K decay occurs less than four K_S mean lives after production. No evidence is found for a CP-violating amplitude. It is pointed out that a combination of experiments of our type, using an initial K^0 state, with experiments using an initial K^0 will provide much more information than either type of experiment alone. This is demonstrated when the results are combined with those of an earlier experiment based on 18 K^0 events. (auth)

37616 DECAY PARAMETERS IN THE NONLEPTONIC DECAY MODES OF THE CHARGED Σ HYPERONS. Berley, D. (Brookhaven National Lab., Upton, N. Y.); Yamin, S. P., Hertzbach, S. S., (and others). Phys. Rev., D; 1: 2015-30(1 Apr 1970).

The final results of a measurement of the decay parameters for $\Sigma^\pm \rightarrow n + \pi^\pm$ are presented. The parameters $\alpha_- = -0.134 \pm 0.034$ and $\alpha_+ = 0.037 \pm 0.049$ are found. Defining ϕ by $\beta = (1-\alpha^2)^{1/2}\sin\phi$, $\gamma = (1-\alpha^2)^{1/2}\cos\phi$, $\phi_- = (-5 \pm 23)°$ and $\phi_+ = (176 \pm 24)°$ are obtained. (auth)

37617 CHARGE ASYMMETRY IN $K_{\pi 3}$ DECAY AND Reϵ. Marx, J. (Columbia Univ., New York); Nygren, D.; Peoples, J., Kirk, T., Steinberger, J. Phys. Lett.; 32B: 219-23(22 Jun 1970).

The charge asymmetry $\delta = (\Gamma^+ - \Gamma^-)/(\Gamma^+ + \Gamma^-)$, where Γ^+ and Γ^- are the partial decay rates for $K_L^0 \rightarrow \pi^-e^+\nu$ and $K_L^0 \rightarrow \pi^+e^-\bar{\nu}$, respectively, was measured in a counter experiment at the Brookhaven AGS. The result $\delta = (3.46 \pm 0.33) \times 10^{-3}$ is found. This result, combined with a previous measurement of δ and the $\Delta S - \Delta Q$ violating parameter x, yields a value for the real part of the CP-violating parameter ϵ: Re$\epsilon = (1.68 \pm 0.17) \times 10^{-3}$. (auth)

37618 CHARGE ASYMMETRY IN THE DECAY $K_L \rightarrow \pi^+\pi^-\pi^0$. Scribano, A. (Univ., Pisa, Italy); Mannelli, I.; Pierazzini, G.; Marx, J.; Nygren, D.; Peoples, J.; Kirk, T.; Steinberger, J. Phys. Lett.; 32B: 224-8(22 Jun 1970).

The CP violating charge asymmetry in the decay $K_L \rightarrow \pi^+\pi^-\pi^0$ was studied, and analyzed in terms of a linear asymmetry with coefficient σ_t, in the difference of the π^+ and π^- kinematic energies (see eq. (1) of the text). No significant asymmetry is found. An upper limit for σ_t of 0.005 can be put with 90% confidence. (auth)

Strong (Baryon-Induced)

Refer also to abstracts 37657, 37803, and 37806.

37619 (COO-1428-212) VERY HIGH ENERGY PROTON PROTON INTERACTIONS: EXPLORATORY SURVEY IN A BUBBLE CHAMBER. (Purdue Univ., Lafayette, Ind. Dept. of Physics). 8 Jun 1970. 13p. Dep. CFSTI.

A bubble chamber study is proposed for the general features of proton proton interactions in the 200 to 500 GeV energy range in as much detail as measuring accuracy permits, starting with charged particle multiplicities, transverse and longitudinal momentum distributions, and detailed measurement of particle systems originating from the target proton, and extending to an exploration of the possibility of doing some four-constraint or equivalent kinematic analysis of complete events. A scanning search for any new or exotic phenomena is an important part of this proposal. There are 100,000 pictures requested initially in a 2 meter or 14 foot hydrogen bubble chamber, with 200 GeV or greater proton beam, $\Delta p/p \leq .1\%$, $\Delta\theta \leq 2$ mrad, and both tolerances better, if possible. (auth)

37620 (COO-1749-12) SEARCH FOR PROTON DECAY AS A TEST OF BARYON CONSERVATION. Dix, Frederick William (Case-Western Reserve Univ., Cleveland, Ohio. Dept. of Physics). Jan 1970. Contract AT(11-1)-1749. 43p. Dep. CFSTI.

Thesis.

A large volume heavy water Cherenkov detector enclosed in a liquid scintillator anticoincidence shield was used to search for proton decay. The 550 gallons of D_2O used were obtained on loan from the Savannah River Plant of the Atomic Energy Commission. The experimental site was located 1950 feet underground to reduce cosmic ray and other background. A lower limit on the proton lifetime of 3.1×10^{23} years was established, independent of the mode of decay. The results were also interpreted to set an upper limit on the ^8B solar neutrino flux of $9.5 \times 10^8\ cm^{-2}\ sec^{-1}$. (auth)

37621 (KFK-1172) THE FINAL STATE INTERACTION IN THE REACTION p + d → p + p + n. Brueckmann, H.; Kluge, W.; Matthaey, H., Schaenzler, L.; Wick, K. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Experimentelle Kernphysik). Apr 1970. 48p. Dep. CFSTI (U. S. Sales Only).

The three-particle reaction d + p → p + p + n was investigated systematically at a deuteron bombarding energy of 52 MeV. Kinematically complete coincidence experiments were carried out. Either two of the protons or the neutron and a proton were detected in coincidence. The kinematical conditions were chosen to observe the effects of n-p and p-p final state interaction predominantly. The Watson-Migdal model of final state interaction was used to analyse the data. An angular distribution was obtained for the production of singlet and triplet final state interacting n-p pairs with zero relative energy in the n-p subsystem. A quantitative relation is established connecting the angular distribution of elastic p-d scattering with the measured angular distribution for triplet final state interaction in the three-nucleon reaction. The validity of the two-step reaction model of n-p final state interaction was checked by angular correlation measurements where one detector was kept at a fixed position. The applicability of the model is confirmed by the experimental results. The p-p final state interaction was investigated at identical kinematical conditions. The angular distribution in the p-p subsystem turns out to be slightly anisotropic but the production of p-p pairs in the $^1S_0$ state is dominating. The result of the systematic study of the reaction p + d → p + p + n proves that values of the n-p and p-p scattering length can be extracted with a high degree of reliability from three-particle reactions at properly chosen kinematical conditions. (auth)

37622 STRIKING REGULARITY IN TOPOLOGIC CROSS SECTIONS FOR p−p AND π⁻−p COLLISIONS. Wroblewski, A. (Univ. of Warsaw). Phys. Lett.; 32B: 145-8(8 Jun 1970).

It is shown that the topologic cross section for the production of k pairs of charged particles is 2^{k-1} times smaller than the cross section for the production of one pair of charges at the same c.m. energy per pair. Possible consequences of this rule are discussed. (auth)

37623 HEAVY-BOSON PRODUCTION IN $\bar{p}p$ MULTIPION ANNIHILATION AT 6.94 GeV/c. Alexander, G.; Bar-Nir, I.; Dagan, S.; Gidal, G.; Grunhaus, J.; Levy, A.; Oren, Y.; Schlesinger, J. (Tel-Aviv Univ., Ramat Aviv, Israel). Phys. Rev. Lett.; 25: 63-6(6 Jul 1970).

Production of heavy bosons is studied in $\bar{p}p$ six-prong annihilations at 6.94 GeV/c. Evidence is presented for the existence of a heavy boson with a mass of 3.035 GeV and a full width of 0.200 GeV decaying into four and six pions. The possible existence of another boson at 3.4 GeV is also discussed. (auth)

37624 MONTE CARLO CALCULATIONS OF THE DOUBLE PRODUCTION OF ^{8}Li NUCLEI IN HIGH ENERGY PARTICLE INTERACTIONS. Bechdorff, Alfred (CNRS, Strasbourg); Annoni, Henri; Gerber, Jean-Paul; Baumann, Germain. Compt. Rend., Ser. B; 270: 637-40(2 Mar 1970). (In French).

The characteristics of production of 61 pairs of ^{8}Li nuclei emitted in high energy interactions are compared with the results obtained through Monte Carlo calculations, assuming that the emission is independent. (France)

37625 MULTIPION PRODUCTION IN DEUTERON–DEUTERON INTERACTIONS AT 7.9 GeV/c. Goshaw, A. T. (Princeton Univ., N. J.); Bazin, M. J. Phys. Rev. Lett.; 25: 50-4(6 Jul 1970).

Pion pair production is studied in the pure state of isospin T = 0 using the reaction dd → dd$\pi\pi$ in a bubble chamber experiment. The data are compared in detail with a one-pion-exchange and a Reggeized one-pion-exchange model including proper Bose symmetrization and the effects of the deuteron spin. No additional $\pi\pi$ interaction is necessary to explain our data. A $\pi\pi$ mass plot in bins close to our experimental resolution is presented as an incentive for bump hunters. (auth)

37626 NEUTRON–PROTON ELASTIC SCATTERING FROM 2 TO 7 GeV/c. Perl, M. L. (Stanford Univ., Calif.); Cox, J.; Longo, Michael J.; Kreisler, M. N. Contract NONR 1224(23). Phys. Rev., D; 1: 1857-82(1 Apr 1970).

Direct measurements were made of neutron-proton elastic scattering differential cross sections at high energies. A neutron beam with a continuous momentum spectrum between 1.2 and 6.7 GeV/c was scattered off a liquid hydrogen target, and spark chambers were used to determine the neutron scattering angle and, in a proton spectrometer, to measure the momentum and scattering angle of the recoil proton. Differential cross sections are presented over the incident neutron momentum range in intervals of the order of 0.5-GeV/c wide. The cross sections have an exponential peak in the forward direction and then flatten and become isotropic about the 90° c.m. scattering angle. At larger angles, the cross sections again rise towards the expected charge-exchange peak, which was not within the range of this experiment. There is little evidence of any other structure in the cross section. Values are presented for the slope of the diffraction peak, and comparisons are made between these slopes, and the 90° c.m. cross sections, for pp and np elastic scattering. The results presented here differ from those previously reported because of an error in a Monte Carlo calculation and in the availability of improved data on the real part of the np elastic scattering amplitude. At 5 GeV/c, a direct comparison of pp and np data allows the I = 0 differential cross section to be extracted. The np data have been fitted in powers of $\cos\theta_{c.m.}$ for $|\cos\theta_{c.m.}| < 0.8$ for each energy range. (auth)

37627 ω PRODUCTION IN pp → pp$\pi^+\pi^-\pi^0$ AT 6.6 GeV/c. Colton, Eugene; Gellert, Eugene (Univ. of California, Berkeley). Phys. Rev., D; 1: 1979-83(1 Apr 1970).

A study of the 3π system in pp → pp$\pi^+\pi^-\pi^0$ at 6.6 GeV/c is presented. Both η(549) and ω(783) production are observed. The Dalitz plot is displayed for the ppω events, in addition to several other experimental distributions. There is no evidence for pω resonances. The ppω events were assigned separately to the six possible multiperipheral diagrams on the basis of criteria in the four-momentum transfers and c.m. longitudinal momenta, respectively. In addition, the means of achieving an effective diagram separation is discussed. (auth)

37628 EXPERIMENTAL TEST OF CHARGE INDEPENDENCE IN n + p → d + π^0. Bartlett, D. F. (Palmer Physical Lab., Princeton, N. J.); Friedberg, C. E.; Goulianos, K.; Hammerman, I. S.; Hutchinson, D. P. Contracts AT(30-1)-2137; N0014-67-A-0151-0001. Phys. Rev., D; 1: 1984-95(1 Apr 1970).

The differential and total cross sections for the reaction n + p → d + π^0 were measured for neutron kinetic energies between threshold (275 MeV) and 700 MeV. Results are presented based on 90,000 events. A comparison is made with existing data for p + p → d + π^+ to test the prediction of charge independence, $d\sigma(np \to d\pi^0) = \frac{1}{2}d\sigma(pp \to d\pi^+)$, at the same c.m. energy and angle. No evidence for a violation is seen. Limits of a few percent are placed on the real part of certain amplitudes for isospin-nonconserving transitions from a study of the symmetry of the angular distributions about $\theta^* = 90°$. (auth)

37629 COMPARISON OF NUCLEON–NUCLEON TOTAL CROSS-SECTION MEASUREMENTS AT 3.00 GeV/c. Riley, K. F. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., D; 1: 2481-2(1 May 1970).

A detailed comparison is made of two independent experiments to determine the total cross sections for 3.00-GeV/c protons on protons and deuterons. Part, but not all, of the discrepancy between the two measurements of the p-d cross section is explained. Best values for the two cross sections are given. (auth)

37630 POSSIBLE EXOTIC EXCHANGE IN pn → $\Delta^-\Delta^{++}$ AT 6.98 GeV/c. Yekutieli, G.; Yaffe, D.; Toaff, S.; Shapira, A.; Ronat, E. E.; Karshon, U.; Haber, B.; Eisenberg, Y. (Weizmann Inst. of Science, Rehovot, Israel). Phys. Rev. Lett.; 25: 184-7(20 Jul 1970).

The reaction pn → $\Delta^-\Delta^{++}$, where Δ^- is emitted in the forward direction in the c.m. system, is observed at 6.98 GeV/c with a cross section of 0.09 ± 0.03 mb. The ratio between this reaction and the reaction pn → $\Delta^{++}\Delta^-$ with Δ^{++} in the forward direction in the c.m. system is found to be $\sigma(\Delta^{++}\Delta^-)/\sigma(\Delta^-\Delta^{++}) = 12.2 \pm 4.5$. The $\Delta^-\Delta^{++}$ production is discussed in terms of exotic meson exchange. (auth)

37631 PROPERTIES OF THE N*(1730). Crennell, David J.; Lai, Kwan Wu; Louie, James; Scarr, J. Michael; Sims, W. H. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. Lett.; 25: 187-91(20 Jul 1970).

The N*(1730) with a mass of 1730 ± 15 MeV and a width of 130 ± 30 MeV is produced in the reaction $\pi^-p \to \pi^-N^*(1730)^+$ at 6 GeV/c. The principal decay mode of this N* is N$\pi\pi$ and not $\Delta\pi$. The Nπ decay is found to be much smaller, and the ΔK decay rate is found to be much larger than the accepted rates for the well-known $N_{\frac{1}{2}}^*$ (1680) states ($D_{\frac{1}{2}}$ and $F_{\frac{1}{2}}$), thus establishing that the object that we observe is not the $N_{\frac{1}{2}}^*$ (1680). (auth)

37632 NEUTRON–PROTON ANGULAR DISTRIBUTION AT 24 MeV. Rothenberg, L. N. (Univ. of Wisconsin, Madison). Phys. Rev., C; 1: 1226-32(Apr 1970).

Proton recoil spectra from n-p elastic scattering are measured with a counter telescope for an incident neutron energy of 24.0 MeV at mean lab proton recoil angles of 8°, 17°, 31°, and 45°, corresponding to c.m. neutron scattering angles of 164°, 146°, 118°, and 89°. The ratio $\sigma(164°)/\sigma(89°)$ is 1.134 ± 0.016, where the error quoted is based on counting statistics. In order to obtain a differential cross section, the c.m. relative angular distribution is normalized to a total cross section of 397.2 mb using an $A(1 + B\cos^2\theta)$ fit. This gives A = 30.1 ± 0.3 mb/sr and B = 0.146 ± 0.017. (auth)

37633 COMPARISON OF PROTON MOMENTUM SPECTRA IN PROTON–PROTON COLLISIONS INVOLVING PION AND KAON PRODUCTION. Abolins, M. A. (Michigan State Univ., East Lansing); Smith, G. A.; Ma, Z. Ming; Gellert, Eugene; Wicklund, A. B. Phys. Rev. Lett.; 25: 126-9(13 Jul 1970).

Striking similarities are found in the proton momentum spectra involving pion and kaon production processes. Except for the falloff near the kinematical limits, the longitudinal-momentum distributions are isotropic. In the transverse-momentum spectra, a sharp break near $P_\perp^2 = 0.2$ (GeV/c)^2 is observed in both processes. The breaks are attributed to the production and decay of peripherally produced nucleon resonances. (auth)

37634 TWO- AND THREE-PION PRODUCTION WITHOUT ANNIHILATION IN ANTIPROTON–PROTON INTERACTIONS AT 2.4 AND 2.9 GeV/c. Jespersen, R. A.; Kernan, W. J.; Leacock, R. A. (Iowa State Univ., Ames). Phys. Rev., D; 1: 2483-93 (1 May 1970).

A study was made of the reaction $\bar{p}p \to \bar{p}p\pi^+\pi^-$. The cross section for this reaction is 1.50 ± 0.07 mb at 2.4 GeV/c and 2.57 ± 0.10 mb at 2.9 GeV/c. The data at both momenta are consistent with nearly 100% $\Delta^{--}\Delta^{++}$ double-resonance production. The reaction is peripheral at both momenta, the distribution of the c.m. scattering angle between the incoming $\bar{p}$ and the outgoing $\bar{p}\pi^-$ system being peaked

at small angles. The $\rho_{1,1}$ spin-density matrix element has strong dependence on Δ^2, the square of the four-momentum transfer from the incoming $\bar{p}$ to the outgoing $\bar{p}\pi^-$ system. The joint spin-density matrix elements indicate no correlation between the $\bar{\Delta}^{--}$ and Δ^{++} production at either momentum. Calculations using the double-isobar one-pion-exchange model with form factors are compared to the data. The reactions $\bar{p}p \to \bar{p}p\pi^+\pi^-\pi^0$, $\bar{p}n\pi^+\pi^+\pi^-$, and $\bar{n}p\pi^-\pi^-\pi^+$ have cross sections of 10 ± 5, 14 ± 10, and 17 ± 10 μb, respectively, at 2.4 GeV/c. The corresponding values at 2.9 GeV/c are 124 ± 40, 143 ± 70, and 127 ± 70 μb. (auth)

37635 MEASUREMENT OF p–p AND p–d TOTAL CROSS SECTIONS AT 3.00 GeV/c. Abrams, R. J.; Cool, R. L.; Giacomelli, G.; Kycia, T. F.; Leontic, B. A.; Li, K. K.; Michael, D. N. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., D; 1: 2477-80(1 May 1970).

In a new measurement of proton total cross sections at 3.00 GeV/c, the p-d total cross section is found to be lower than a previous measurement by 1.17 ± 0.09 mb. This implies a corresponding new value for the total cross section for I = 0 which is 2.18 ± 0.27 mb lower than the previous value. Possible sources of systematic error are discussed. (auth)

37636 BREAK-UP REACTION p + d → p + p + n. Brueckmann, H.; Gehrke, W.; Kluge, W.; Matthaey, H.; Schaenzler, L.; Wick, K. (Univ., Karlsruhe, Ger. Kernforschungszentrums, Karlsruhe, Ger.). Z. Phys.; 235: 453-62(1970).

The three-particle reaction p + d → p + p + n was investigated at a deuteron bombarding energy of 52.0 MeV. Single counter experiments as well as coincidence measurements were carried out. The laboratory angular distribution of the break-up reaction and the total break-up cross section were determined by means of the single counter experiments. The angular distribution for final-state interacting neutron–proton pairs was obtained by means of coincidence measurements. The coincidence experiments provide a strong evidence for very different shapes of the angular distributions for neutron–proton singlet and triplet final-state interaction. (auth)

Strong (Meson-Induced)

Refer also to abstracts 36616, 37622, and 37801.

37637 (COO–1428-176) DECAY OF SOME HIGH MASS BOSONS TO $\pi^+\pi^0$. Kramer, S. L.; Barton, H. R. Jr.; Gutay, L. J.; Lichtman, S.; Miller, D. H.; Scharenguivel, J. H. (Purdue Univ., Lafayette, Ind. Dept. of Physics). [1970]. 13p. Dep. CFSTI.

Evidence is presented for three boson structures with masses 1.65, 1.97 and 2.16 GeV/c^2 and widths less than 80 MeV/c^2 from a study of the reaction $\pi^+p \to p\pi^+\pi^0$ at 13.1 GeV/c. These structures are shown to have $I^G = 1^+$, therefore excluding even J assignments. This result favors the interpretation of the 1.97 state as a member of the A_2 daughter trajectory. (auth)

37638 (COO–1428-203) ANNUAL PROGRESS REPORT [ON PARTICLE PHYSICS], JUNE 1, 1969–MAY 31, 1970. Loeffler, F. J. (Purdue Univ., Lafayette, Ind. Dept. of Physics). Contract AT(11-1)-1428. 23p. Dep. CFSTI.

The research accomplished during the period is briefly summarized. Various particle interactions analyzed using the bubble chamber are discussed. The measuring-computing system is described, also. A list of publications is given. (J.F.P.)

37639 (COO–1428-210) PROPOSAL TO STUDY SINGLE MESON PRODUCTION IN MESON NUCLEON INTERACTIONS AT 50 AND 100 GeV/c. (Purdue Univ., Lafayette, Ind.). 10 Jun 1970. 29p. Dep. CFSTI.

It is proposed to study the general type of reaction meson + nucleon → meson + meson + nucleon. In particular, it is first proposed to analyzing the specific t channel reactions $\pi^-p \to n + \pi^+ + \pi^-$, $\pi^-p \to n + K^+ + K^-$, $\pi^+p \to n + \pi^+ + \pi^+$, $K^-p \to n + K^- + \pi^+$, and $K^+p \to n + K^+ + \pi^+$ with a spectrometer or hybrid spectrometer. The physics to be obtained would be: Study of high mass resonant states to obtain widths, positions, coupling constants, spin-parities and G parities. Study of the one pion exchange contribution for the above reactions at high energies. Study of the $\pi\pi$ scattering amplitudes in the T = 2, 1 and 0 isospin states. Study of the diffractive single meson production process at the nucleon vertex and its interference with the one particle exchange single meson production process. Obtain information on the properties of the Pomeron trajectory (diffraction scattering) from the $\pi^+\pi^+$, angular distribution. We would also study such reactions as $\pi^+p \to \Sigma^+K^+$ which have essentially the same requirements. (auth)

37640 (COO–1428-213) DIFFRACTIVE PROCESS IN π^-p INTERACTIONS AT 100 GeV/c. (Purdue Univ., Lafayette, Ind. Dept. of Physics). 15 Jun 1970. 7p. Dep. CFSTI.

A study of diffractively produced hadron systems from 100 GeV/c π^- interactions in a 15 foot hydrogen bubble chamber is proposed. Primary interest is in the 4C reactions $\pi^-p \to p\pi^-\pi^-\pi^+$ and $\pi^-p \to p\pi^-\pi^-\pi^+\pi^+$. Use of the chamber as a missing mass spectrometer for other four and six pronged interactions is proposed, also. A total of 500,000 photographs is requested. (auth)

37641 (COO–1428-215) OBSERVATION OF N*(1720) DECAY TO $\Delta(1236)\pi$ FROM π^+p INTERACTIONS AT 13.1 GeV. Willmann, R. B.; Lamsa, J. W.; Gaidos, J. A.; Ezell, C. R. (Purdue Univ. Lafayette, Ind. Dept. of Physics). [1970]. 13p. (CONF-700806-13). Dep. CFSTI. From 15th International Conference on High Energy Physics, Kiev, USSR.

Evidence is presented for the production of N*(1720) (M = 1719 ± 6 MeV, $\Gamma = 63 \pm 12$ MeV) and subsequent decay to $\Delta(1236)\pi$ in π^+p interactions at 13.1 GeV. Analysis of the sequential decay $N^*(1720) \to \Delta^{++}\pi^- \to p\pi^+\pi^-$ limits the spin to values greater than $\frac{1}{2}$. (auth)

37642 (COO–1428-217) DOUBLE-REGGE POLE ANALYSIS OF $\pi^+p \to \pi^+\pi^-\Delta^{++}$ AT 13.1 GeV/c. Gaidos, J. A.; Ezell, C. R.; Lamsa, J. W.; Willmann, R. B. (Purdue Univ., Lafayette, Ind.) [1970]. 22p. (CONF-700806-2). Dep. CFSTI. From 15th International Conference on High Energy Physics, Kiev, USSR.

A double-Regge model is applied to the reaction $\pi^+p \to \pi^+\pi^-\Delta^{++}$ at 13.1 GeV/c. A good description of the data is given in terms of two amplitudes involving Pomeranchuk/π and Pomeranchuk/Δ exchanges. (auth)

37643 (COO–1428-218) DOUBLE-REGGE-POLE ANALYSIS OF $\pi^+p \to \pi^+\rho^0p$ AT 13.1 GeV/c. Gaidos, J. A.; Ezell, C. R.; Lamsa, J. W.; Willmann, R. B. (Purdue Univ., Lafayette, Ind.) [1970]. 33p. (CONF-700806-3). Dep. CFSTI. From 15th International Conference on High Energy Physics, Kiev, USSR.

A double-Regge-exchange analysis of the reaction $\pi^+p \to \pi^+\rho^0p$ at 13.1 GeV/c is presented. The events are divided into proton diffractive (~80%) and pion diffractive (~20%) categories, each of which requires two double-Regge amplitudes for a complete description. The data of each sample are well described by a double-Regge model consistent with duality. (auth)

37644 (COO–1428-220) THE REACTION $\pi d \to d\pi^+\pi^+\pi^-$ AT 13 GeV/c. Paler, K.; Badewitz, R. C.; Barton, H. R. Jr.; Miller, D. H.; Palfrey, T R. Jr.; Tebes, J. (Purdue Univ., Lafayette, Ind. Dept. of Physics). [1970]. 10p. (CONF-700806-12). Dep. CFSTI. From 15th International Conference on High Energy Physics, Kiev, USSR.

Preliminary results obtained for the reaction $\pi^+d \to d\pi^+\pi^+\pi^-$ at 13 GeV/c are presented. The reaction is dominated by the production of three pion states with masses near the $\rho\pi$ threshold. The neutral dipion effective mass spectrum is dominated by ρ^0 production. The reaction is very peripheral being characterized by the deuteron differential cross section of $d\sigma/dt = A \exp(29t)$. (auth)

37645 (COO-1428-221) BOSON STRUCTURES IN THE REACTION $\pi^+p \to p\pi^+\pi^0$ AT 13.1 GeV/c. Kramer, S. L.; Barton, H. R. Jr.; Gutay, L. J.; Lichtman, S.; Miller, D. H.; Scharenguivel, J. H. (Purdue Univ., Lafayette, Ind. Dept. of Physics). [1970]. 14p. (CONF-700806-5). Dep. CFSTI.

From 15th International Conference on High Energy Physics, Kiev, USSR.

Evidence is presented for three boson structures with masses 1.65, 1.97 and 2.16 GeV/c^2 and widths less than 80 MeV/c^2 from a study of the reaction $\pi^+p \to p\pi^+\pi^0$ at 13.1 GeV/c. These structures are shown to have $I^G = 1^+$, therefore excluding even J assignments. This result favors the interpretation of the 1.97 state as a member of the A_2 daughter trajectory. (auth)

37646 (COO–1428-222) HIGH MASS BOSON PRODUCTION IN π^+p INTERACTIONS AT 13.1 GeV/c. Miller, D. H.; Kramer, S. L.; Ezell, C. R.; Gaidos, J. A.; Gutay, L. J.; Lamsa, J. W.; Lichtman, S.; Mulera, T.; Scharenguivel, J. H.; Willmann, R. B. (Purdue Univ., Lafayette, Ind.) [1970]. 12p. (CONF-700806-8). Dep. CFSTI. From 15th International Conference on High Energy Physics, Kiev, USSR.

The R, S, T, U, and X meson resonance production in $\pi^+ + p$ interactions at 13.1 GeV/c in a bubble chamber is studied and compared with that of the CERN Boson Spectrometer group. Various histograms are shown for these data. (J.F.P.)

37647 (COO–1428-223) A STUDY OF THE REACTIONS $\pi^+p \to \pi^+pK^+K^-$ AND $\pi^+p \to \pi^+pp\bar{p}$ AT 13.1 GeV/c. Mulera, T. A.; Ezell, C. R.; Gaidos, J. A.; Lamsa, J. W.; Willman, R. B. (Purdue Univ., Lafayette, Ind. Dept. of Physics). [1970]. 9p. (CONF-700806-9). Dep. CFSTI. From 15th International Conference on High Energy Physics, Kiev, USSR.

Events corresponding to the reactions $\pi^+p \to \pi^+p\,K^+K^-$ and $\pi^+p \to \pi^+pp\bar{p}$ were selected from a 230,000 picture π^+p exposure at 13.1

GeV/c in the 82" SLAC bubble chamber. The events were selected by the technique of forced balance of the unfitted energy and momentum. The first reaction is dominated by the production of K^{*0}(890) and N^{*++}(1236). Production of the K_N(1420) is also observed. Enhancements in the K^+K^- mass spectrum are observed at 1030 and 1240 MeV. The second reaction is dominated by N^* (1236) production. The enhancement reported at 3755 MeV in the ppp mass spectrum is not observed. (auth)

37648 (COO-1428-224) DECAY PROPERTIES OF THE D^0 MESON. Miller, W. J.; Campbell, J. H.; Lichtman, S.; Loeffler, F. J.; Miller, D. H.; Miller, R. J.; Willmann, R. B. (Purdue Univ., Lafayette, Ind.). [1970]. 8p. (CONF-700806-19). Dep. CFSTI.

From 15th International Conference on High Energy Physics, Kiev, USSR.

A maximum likelihood fit to the $\eta\pi\pi$ Dalitz plot using $\pi^+d \rightarrow p_s p\pi^+\pi^-\eta$ data at 2.7 and 3.1 GeV/c shows events in the D region concentrated in the center of the Dalitz plot. (auth)

37649 (COO-1428-225) A MULTIPERIPHERAL ANALYSIS OF THE REACTION $\pi^+d \rightarrow p_s p\pi^+\pi^-\pi^0$ AT 13 GeV/c. Barton, H. R. Jr.; Badewitz, R. C.; Miller, D. H.; Paler, K.; Palfrey, T. R. Jr.; Tebes, J. (Purdue Univ., Lafayette, Ind.). Aug. 1970. 18p. (CONF-700806-15). Dep. CFSTI.

From 15th International Conference on High Energy Physics, Kiev, USSR.

The reaction $\pi^+d \rightarrow p_s p\pi^+\pi^-\pi^0$ was studied at 13 GeV/c incident π^+ momentum in a 260,000 picture exposure taken in the 82" deuterium bubble chamber at the Stanford University Linear Accelerator. The data are characterized by meson charge exchange, i.e., a neutral pion is produced at low momentum transfer relative to the π^+ beam. This characteristic of the reaction plus charge exchange at the nucleon vertex prohibit Pomeranchuk exchange. A triple-peripheral model which is capable of reproducing the data is discussed. The momentum transfer and effective mass distributions observed in this experiment are compared with model calculations. (auth)

37650 (UR-875-312) A SEARCH FOR Q PRODUCTION IN CHARGE EXCHANGE REACTIONS. Werner, B.; Slattery, P.; Ferbel, T. (Rochester Univ., N. Y. Dept. of Physics and Astronomy). 1 Jul 1970. Contract AT(30-1)-875. 15p. (CONF-700806-14). Dep. CFSTI.

From 15th International Conference on High Energy Physics, Kiev, USSR.

The $K\pi\pi$ enhancement at low mass (the Q effect) has been observed in $K^\pm N$ interactions only in the same charge state as the incident beam particle. The lack of observation of the Q in other charge states has been cited as evidence for the diffractive nature of Q production. The cross section for dissociation of the K meson coupled with charge exchange at the nucleon vertex is expected to be ~1/100 that for diffractive dissociation. In order to obtain sufficient statistics for the study of Q^{++} and Q^0 production in $K^+p \rightarrow nK^0_1\pi^+\pi^+$ the $K^0\pi^+\pi^+$ mass spectra observed in several experiments are combined. These data will be compared with the predictions of a multiperipheral model. (auth)

37651 (UR-875-313) QUASI TWO-BODY REACTIONS AND MOMENTUM TRANSFER DEPENDENCES IN K^+p INTERACTIONS AT 12.7 GeV/c. Holmes, R. S.; Berlinghieri, J. C.; Farber, M.; Ferbel, T.; Slattery, P.; Werner, B.; Yuta, H. (Rochester Univ., N. Y. Dept. of Physics and Astronomy). 2 Jul 1970. Contract AT(30-1)-875. 15p. (CONF-700806-4). Dep. CFSTI.

From 15th International Conference on High Energy Physics, Kiev, USSR.

A study of quasi two-body production in K^+p interactions at 12.7 GeV/c is presented. The reactions (1) $K^+p \rightarrow K^{*+}(890)p$, (2) $K^+p \rightarrow K^0\Delta^{++}$, and (3) $K^+p \rightarrow K^{*0}(890)\Delta^{++}$ are from a 10 event/μb exposure of the BNL 80-inch HBC. Cross sections and production mechanisms are discussed. Also the momentum transfer dependences in reactions of the kind $A\,p \rightarrow A^*\,\Delta^{++}$ are examined and it is noted that for $(A,A^*) = [K^+, K^{*0}(890)]$, $[K^+, K^{*0}(1420)]$, (π^+,ρ^0), (π^+,f^0), (p^-,Δ^{3-}), or for any $(A\pi)^0$ continuum, the t-dependence is described very precisely by the square of the pion propagator, i.e., by the form $1/(t+\mu^2)^2$. (auth)

37652 PRODUCTION OF THE L MESON IN THE FINAL STATE $K^-p \rightarrow K^-\pi^+\pi^-p$ AT 4.6 GeV/c. Aguilar-Benitez, M.; Barnes, V. E.; Bassano, D.; Chung, S. U.; Eisner, R. L.; Flaminio, E.; Kinson, J. B.; Palmer, R. B.; Samios, N. P. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. Lett.; 25: 54-8(6 Jul 1970).

Evidence is presented for production of the L meson ($M = 1745 \pm 20$ MeV and $\Gamma = 100 \pm 50$ MeV) in the reaction $K^-p \rightarrow K^-\pi^+\pi^-p$ at an incident momentum of 4.6 GeV/c. It decays mainly into $K^-\pi^+\pi^-$, of which (20 ± 20) % goes via the K(1420)π state. No significant evidence is found for K(890)π, Kω, Kφ, Kη decay modes. One does not observe $K\pi\pi$ threshold enhancements for arbitrary $K\pi$ mass selections. (auth)

37653 OBSERVATION OF Σ RESONANCES IN THE 1670-MeV MASS REGION. Aguilar-Benitez, M. (Brookhaven National Lab., Upton, N. Y.); Barnes, V. E.; Bassano, D.; Chung, S. U.; Eisner, R. L.; Flaminio, E.; Kinson, J. B.; Samios, N. P.; Jaeger, K. Phys. Rev. Lett.; 25: 58-63(6 Jul 1970).

Confirmation is presented for the existence of two Σ(1670) resonances on the basis of their different production angular distributions. One of these decays predominantly into Λ(1405)π and is produced much more peripherally than the second, whose principal decay mode is $\Sigma\pi$. (auth)

37654 TWO-NUCLEON INTERACTIONS OF K^- MESONS IN DEUTERIUM. Veirs, V. R.; Burnstein, R. A. (Illinois Inst. of Tech., Chicago). Phys. Rev., D; 1: 1883-6(1 Apr 1970).

Direct measurements of all two-nucleon interactions of stopping K^- mesons in deuterium were made in a bubble-chamber experiment. The production rates relative to the single-nucleon interactions of K^- are $R(K^-d \rightarrow \Sigma^-p) = (0.505 \pm 0.036)\%$, $R(K^-d \rightarrow \Sigma^0n) = (0.337 \pm 0.070)\%$, and $R(K^-d \rightarrow \Lambda n) = (0.387 \pm 0.041)\%$. The ratio of the rates $R(K^-d \rightarrow \Sigma^-p)$ and $R(K^-d \rightarrow \Sigma^0n)$ is consistent with the prediction of isotopic-spin invariance for the strong interactions. The total two-nucleon production rate is $(1.22 \pm 0.09)\%$ and is compared with current theoretical predictions. (auth)

37655 STRUCTURES IN $K^\pm$-NUCLEON TOTAL CROSS SECTIONS BETWEEN 0.9 AND 2.4 GeV/c. Cool, R. L.; Giacomelli, G.; Kycia, T. F.; Leontic, B. A.; Li, K. K.; Lundby, A.; Teiger, J.; Wilkin, C. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., D; 1: 1887-1917(1 Apr 1970).

Total cross sections of $\pi^\pm$ and $K^\pm$ on hydrogen and deuterium were measured in a standard transmission experiment in the momentum range 0.9 to 2.4 GeV/c at 50-MeV/c intervals with statistical precisions in the range of 0.2-1.0%. Cross sections for pure isotopic spin states were obtained using a procedure for the deuterium data which takes into account Fermi motion and the shadow effect. This procedure was tested on the pion data before applying it to kaons. Evidence for the following new structures was found: Y^0_δ(2107), Y^0_δ(2344), Y^1_1(1912), Y^1_1(2025), Y^1_1(2255), Z^0_δ(1780), and Z^1_1(1900). (auth)

37656 Ξ^- PRODUCTION IN 5.5-GeV/c K^-p INTERACTIONS. Goldwasser, E. L.; Schultz, P. F. (Univ. of Illinois, Urbana). Phys. Rev., D; 1: 1960-6(1 Apr 1970).

Final states with a Ξ^- hyperon were studied in 5.5-GeV/c K^-p interactions. Center-of-mass production angular distributions for the Ξ^- have a peak in the beam direction, while those for the K^+ or K^0 meson peak in the opposite direction. Approximately half of the observed events involve the Ξ^*(1530) or K^*(890) resonances. The four-and five-body final states show production of the Ξ^*(1930) in the $\Xi^-\pi^+\pi^0$ mass spectrum and a narrow peak at 2295 MeV in the $\Xi^-\pi^+\pi^-$ mass spectrum. The mass of the Ξ^- hyperon is 1321.9 ± 0.5 MeV as determined from 195 Ξ^- decays with a visible Λ decay, assuming a Λ-hyperon mass of 1115.58 MeV. (auth)

37657 TOTAL CROSS SECTIONS OF $K^\pm$ MESONS AND ANTIPROTONS ON NUCLEONS UP TO 3.3 GeV/c. Abrams, R. J.; Cool, R. L.; Giacomelli, G.; Kycia, T. F.; Leontic, B. A.; Li, K. K.; Michael, D. N. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., D; 1: 1917-35(1 Apr 1970).

Total cross sections of $K^\pm$ and $\bar{p}$ on hydrogen and deuterium were measured in a standard transmission experiment with statistical precisions of the order of 0.05-0.25%. Data were obtained in the momentum range 2.45 to 3.30 GeV/c for K^-N, 1.55 to 3.30 GeV/c for K^+N, and 1.00 to 3.30 GeV/c for $\bar{p}N$. Cross sections for the pure isotopic spin states are obtained using a procedure for the deuterium data which takes into account Fermi motion and the shadow effect. Evidence for the following new structures was found: Y^0_δ(2455), Y^1_δ(2620), Y^0_δ(2585), Z^1_δ(2150), Z^1_δ(2500), π^1_δ(2190), π^1_δ(2350), and π^0_δ(2375). (auth)

37658 K^-p AMPLITUDES NEAR THE Λ(1520). Berley, D. (Brookhaven National Lab., Upton, N. Y.); Yamin, S. P.; Kofler, R. R.; Mann, A.; Meisner, G. W.; Yamamoto, S. S.; Thompson, J.; Willis, W. Phys. Rev., D; 1: 1996-2015(1 Apr 1970).

$\bar{K}^0n$, $\Lambda\pi^0$, and $\Sigma^0\pi^0$ final-state cross sections and $\Lambda\pi^0$ and $\Sigma^0\pi^0$ polarizations are obtained in K^-p interactions, for P_{K^-} in the range 350 to 430 MeV/c, near the Λ(1520) resonance. Two fits to the partial-wave amplitudes have been found, both assuming a standard Breit-Wigner amplitude for the Λ(1520) resonance and a constant-scattering-length $D_{\frac{3}{2}}$ isospin-1 amplitude, but differing in their treatment of the S- and P-wave backgrounds. One method used a constant K matrix, the other a momentum-dependent effective-range expansion for the inverse of the K matrix. From the

fitted partial waves, an upper limit of 10% is set for an isospin mixing between the $\Lambda\pi^0$ and $\Sigma^0\pi^0$ amplitudes. (auth)

37659 K^+p ELASTIC DIFFERENTIAL CROSS SECTION MEASUREMENTS BETWEEN 1.4 AND 2.3 GeV/c AND A PHASE SHIFT ANALYSIS. Barber, P. C. (University Coll., London); Broome, T. A.; Duff, B. G.; (and others). Phys. Lett.; 32B: 214-18(22 Jun 1970).

The differential cross section for K^+p elastic scattering was measured at 26 momenta between 1.4 and 2.3 GeV/c. The data were included in a phase shift analysis; four solutions were found, none of which requires the existence of a Z_1^+ resonance. (auth)

37660 REACTION $K^+p \rightarrow K^+\pi^+\pi^-p$ AT 2.53, 2.76, AND 3.20 GeV/c. Abrams, G. S.; Eisenstein, L.; Kim, J.; Marshall, D.; O'Halloran, T. A. Jr.; Shufeldt, W.; Whitmore, J. (Univ. of Illinois, Urbana). Phys. Rev., D; 1: 2433-46(1 May 1970).

The reaction $K^+p \rightarrow K^+p\pi^+\pi^-$ is studied at incident beam momenta of 2.53, 2.76, and 3.20 GeV/c, using the Argonne 30-in. hydrogen bubble chamber. Cross sections for the production of K^{*0}(890), N^{*++}(1236), and the double-resonance channel $K^+p \rightarrow K^{*0}$(890)N^{*++}(1236) were determined. The production and decay angular distributions for the double-resonance channel were with the predictions of several models which assume pion exchange. The decay angular distributions were also compared with quark-model predictions. It is found that none of the models tested completely accounts for all the features of the data. In addition, a low-mass enhancement in the $K\pi\pi$ system at 1300 ± 10 MeV is observed. (auth)

37661 $\pi\pi$ SCATTERING UP TO 1.4 GeV OF DIPION MASS. Oh, B. Y. (Univ. of Wisconsin, Madison); Garfinkel, A F.; Morse, R.; Walker, W. D.; Prentice, J. D.; West, E. C.; Yoon, T. S. Contact AT(11-1)-881. Phys. Rev., D; 1: 2494-2513(1 May 1970).

$\pi\pi$ scattering up to 1.4 GeV of dipion mass is studied from the reactions $\pi^-p \rightarrow \pi^-\pi^+n$ and $\pi^-\pi^0p$ at 7 GeV/c, using the formalism of absorption-modified one-pion exchange (OPE) with dipion in S, P, and D waves. The analysis is limited to small momentum transfers to the nucleon, including the nucleon-pole terms as background. The ρ^0, ρ^-, and f^0 mesons, and the $\pi^-\pi^+$ anomaly in the 1.0 to 1.2-GeV region are analyzed. The S-, P-, and D-wave $\pi\pi$ phase shifts and inelasticities, of isospin 0, 1, and 2, are obtained. (auth)

Particle Interactions and Properties (Theoretical)

General

Refer also to abstracts 37910 and 38322.

37662 (UCRL-19415) PHYSICS SEMIANNUAL REPORT, MAY-OCTOBER 1969. (California Univ., Berkeley. Lawrence Radiation Lab.). Dec 1969. 126p. Dep. CFSTI.

A summary of research at the Lawrence Radiation Laboratory during the period from May to October 1969 is presented. This research is theoretical and experimental and covers high-energy physics primarily, although some atomic and plasma physics is also studied. Computing and data handling and accelerator operation and development are also covered. Lists of publications and papers are included. (J.F.P.)

37663 HIGH ENERGY PHYSICS INDEX. VOLUME 8, NO. 8, 1970. Frankfurt am Main; Zentralstelle fuer Atomkernenergie-Dokumentation (1970). 71p.

37664 WAVE FUNCTION WITH MULTIPLE REPRESENTATION FOR PARTICLES POSSESSING 0 SPIN. Pletyukhov, V. A.; Fedorov, F. I. (Belorussian State Univ., Minsk). Vestsi Akad. Navuk BSSR, Ser. Fiz.-Mat. Navuk; No. 2, 79-85(1970). (In Russian).

Earlier results were used to study wave functions involving a special correlation scheme for the equations. On that basis, a relativistic wave function was derived for particles with 0 spin, applying the double vector representation of the specific Lorentz group. The derivation indicated that the 15th-order matrices possess a polynomial with a minimum value of $\gamma^3(\gamma^2 - 1)$. The scattering cross section of a given particle in the Coulomb field was found to coincide with the usual value, as long as the Compton effect cross section differs from the Daffin-Kremmer effect for particles with 0 spin. (TTT)

37665 NONDYNAMICAL STRUCTURE OF PARTICLE REACTIONS CONTAINING IDENTICAL PARTICLES. Csonka, Paul L.; Moravcsik, Michael J. (Univ. of Oregon, Eugene). Phys. Rev., D; 1: 1821-34(15 Mar 1970).

That part of the structure of particle reactions of arbitrary spins which is independent of dynamics is investigated in the case when identical particles are contained in the reaction. First, a general discussion of the structure of composite reactions reveals that mirror re! itions arise naturally in such reactions even when the characteristic quantity contains an even number of letters. It is also shown that there is a close analogy between the constraints of time-reversal invariance and those of identical particles, as applied to their respective self-transforming reactions. It is then easy to determine the changes in the tests of other conservation laws, like parity conservation and time-reversal invariance, in the presence of identical particles. It is found that some tests are erased by the presence of identical particles; others are simplified. With one exception, however, the presence of identical particles does not preclude tests of other symmetries for a reaction. Identical particles also widen the range of self-transforming reactions. Relatively little can be said about reactions with only one pair of identical particles. Two examples illustrate the results in detail. (auth)

37666 HIGH ENERGY PHYSICS INDEX. VOLUME 8, NO. 9, 1970. Frankfurt am Main; Zentralstelle fuer Atomkernenergie-Dokumentation (1970). 63p.

37667 TIME DEPENDENCE OF ELEMENTARY PROCESSES. Kerler, W. (Univ., Marburg, Ger.). Z. Phys.; 234: 330-46 (1970).

There are a number of inequivalent descriptions of time-dependent processes, which give approximately the same time dependence in standard cases. However, substantial differences occur for other situations. Also, looking for finer details makes sense only if one has an adequate description. Moreover, unique prescriptions are of importance for the study of weak interactions. Therefore typical experimental situations and their connection with quantum theoretic probabilities are analyzed. The most important cases are considered in detail. If stable, possibly composite particles are observed initially and finally, everything can be based on the exact formulation of multichannel scattering theory. If unstable particles are actually detected, suitable Hilbert space vectors have to be defined. Various properties of the resulting probabilities are pointed out. Usual approaches are critically discussed. (auth)

37668 CLASSICAL ELECTRODYNAMICS AS PROPERTIES OF MOMENTUM SPACE. Dalton, B. J. (Florida State Univ., Tallahassee). Phys. Lett.; 32B: 211-13(22 Jun 1970).

Using a momentum space de Sitter line element, current densities and field tensors are constructed from the generators and eigenfunctions of the group Casimir invariants. The geometric relations between these quantities satisfy all properties of Maxwell's equations and CPT invariance. (auth)

37669 CLASSIFICATION OF PARAPARTICLES. Stolt, Robert H.; Taylor, John R. (Univ. of Colorado, Boulder). Phys. Rev., D; 1: 2226-8(15 Apr 1970).

Hartle and Taylor have shown that the cluster law imposes certain restrictions on the allowed symmetries of first-quantized systems of identical particles. Their results are extended to show that all particles which are neither bosons nor fermions and which obey the cluster law can be divided into two classes, those of finite order, and those of infinite order. For every positive integer p there are two types of finite-order particle, which are called parabosons and parafermions of order p. Ordinary bosons and fermions can be fitted into this scheme as particles of order 1. It is conjectured that the finite-order particles can be identified with the parafermions and parabosons of the second-quantized, parafield theory. Infinite-order particles would seem to have no analog in the second-quantized theory, as presently formulated. (auth)

37670 CONSTRUCTION OF THREE- AND FOUR-POINT FUNCTIONS OF CURRENTS FOR ARBITRARY SPIN-ONE SPECTRAL FUNCTIONS. Nutbrown, D. A. (Univ. of Rochester, N. Y.). Phys. Rev., D; 1: 2328-34(15 Apr 1970).

A model is presented for three- and four-point functions of currents which satisfies the Ward identities implied by chiral SU(2) × SU(2) for arbitrary vector and axial-vector spectral functions. In the limit in which the spectral functions are single-particle dominated, the three- and four-point functions of the usual hard-pion approach are recovered. However, this limit is not forced upon us by the assumption of smoothness of primitive vertices, since the singularity structure is extracted in a manner somewhat different from the hard-pion approach. (auth)

37671 TACHYON CLOUD OF A PARTICLE. Sudarshan, E. C. G. (Univ. of Texas, Austin). Phys. Rev., D; 1: 2428 (15 Apr 1970).

The similarities and differences of a tachyon cloud surrounding a slower-than-light particle compared to that of a meson cloud

surrounding a nucleon are given, and a possible elimination of the infrared-divergence catastrophe in terms of renormalization due to the tachyon cloud is pointed out. (auth)

37672 UNITARITY AND INTERACTING TACHYONS. Boulware, David G. (Univ. of Washington, Seattle). Contract AT(45-1)-1388. Phys. Rev., D; 1: 2426-7(15 Apr 1970).

It is shown, by an explicit calculation, that the Dhar-Sudarshan theory of tachyons is not unitary. (auth)

37673 ABOUT ANTICAUSALITY AND TACHYONS. Recami, E. (Univ., Catania, Italy). Lett. Nuovo Cim.; 4: 73-4(11 Jul 1970).

Comments are made on a paper by Thouless (Nature, 224: 506 (1969)) in which a paradox against the existence of tachyons was put forward. The paradox was based on the belief that causality necessarily requires the common chronological order of causes and effects. (L.B.S.)

37674 HIGH ENERGY PHYSICS INDEX. VOLUME 8, NO. 12, 1970. Frankfurt am Main; Zentralstelle fuer Atomkernenergie-Dokumentation (1970). 60p.

37675 HIGH ENERGY PHYSICS INDEX. VOLUME 8, NO. 11, 1970. Frankfurt am Main; Zentralstelle fuer Atomkernenergie-Dokumentation (1970). 63p.

37676 ANALYSIS OF THE EXPERIMENTAL MEANING OF COHERENT SUPERPOSITION AND THE NONEXISTENCE OF SUPERSELECTION RULES. Mirman, R. (Long Island Univ., Brooklyn). Phys. Rev., D; 1: 3349-63(15 Jun 1970).

The experimental meaning of coherent superposition of state vectors is analyzed. It is shown that the involvement of the measuring instrument is of basic importance and that it is erroneous to study superposition without it. From this analysis it is found that there are no such things as superselection rules. The meaning of the sign change of spinors under 2π rotation is considered, and it is found to have experimental consequences. The nonmeasurability of the relative parity of states with different z components of angular momentum is shown. An appendix discusses the application of some of these considerations to decaying states and elementary particles. (auth)

37677 RELATIVISTIC CORRECTIONS TO THE THREE-BODY PROBLEM. Jacob, H.; Bhasin, V. S.; Mitra, A. N. (Univ. of Delhi). Phys. Rev., D; 1: 3496-3501(15 Jun 1970).

Relativistic corrections are evaluated for a model three-body problem consisting of three identical bosons in s-wave pairs through separable potentials. For the potentials, Shirokov's second-order (in v/c) correction, which vanishes in the c.m. frame of a two-body system, is considered. No corrections are considered for the kinetic energy, as it is argued that any such correction is intimately linked with the precise structure assumed for a three-particle dynamics and cannot merely be incorporated through the modification $p^2/2m \rightarrow (m^2 + p^2)^{\frac{1}{2}} - m$ for each particle, which affects even the two-particle dynamics on the energy shell (and hence also the parameters of the two-body potential). The reduction in the quantity analogous to the binding energy of the triton is found to be of the order of 5%, while the curve for the counterpart of the doublet n-d scattering length (a_4) versus the two-body strength parameter (λ) is slightly shifted to the right as a result of the relativistic correction. (auth)

Electromagnetic

Refer also to abstracts 37670, 37728, 37748, 37762, 37798, 37840, 37842, and 38091.

37678 (SLAC-PUB-746) NEW RESULTS ON HIGH-ENERGY ELECTROMAGNETIC INTERACTIONS. Taylor, R. E. (Stanford Linear Accelerator Center, Calif.). May 1970. 29p. (CONF-700314-3). Dep. CFSTI.

From International Conference on Expectations for Particle Reactions at the New Accelerators, Madison, Wis.

Summaries of research are presented for quantum electrodynamics, total photon-nucleon cross section, and electron scattering. (J.F.P.)

37679 ASYMPTOTICS OF FEYNMAN GRAPHS WITH INFRARED DIVERGENCES AND COULOMB INTERFERENCE. Solov'ev, L. D., Shchelkachev, A. V. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 11: 430-6(Feb 1970). (In Russian).

Electromagnetic corrections to the hadron elastic scattering amplitude at high energies are investigated with a simple relativistic model as an example. In the model the amplitude is described by simple Feynman graphs. A method is developed to obtain asymptotics of the Feynman integrals with infrared divergences. (auth)

37680 QUANTUM THEORY OF ELECTRON MOTION IN CYCLIC RESONANCE ACCELERATOR. Bagrov, V. G.; Sokolov, A. A.; Ternov, I. M. (Moscow State Univ.). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 4, 12-22(1970). (In Russian).

Relativistic electron motion in a focusing steady-state magnetic field in the presence of a high-frequency vorticity electromagnetic field compensating radiation energy losses were studied using the Klein–Gordon equation. Equations obtained may be used in construction of the theory of electron storage rings where quantum oscillations are of great importance. (tr-auth)

37681 ELECTROMAGNETIC PROPERTIES OF THE DIRAC PARTICLES. Pac, P. Y. (Seoul National Univ.). J. Korean Nuc. Soc.; 1: 103-6(Dec 1969).

A new representation for the Dirac equation, which may be appropriate to describe the interaction of the charged particle with the electric field, is derived by introducing a gauge-independent unitary transformation. It is shown that in this representation the effective Hamiltonian without potentials has a new feature in the nonrelativistic limit. (auth)

37682 ANALYSIS OF PION PHOTOPRODUCTION ON NUCLEONS BELOW 500 MeV. Kondo, Kunitaka; Nishikawa, Tetsuji; Suzuki, Toshio; Takikawa, Koji; Kimura, Yoshitaka (Tokyo Univ.). J. Phys. Soc. Jap.; 29: 30-42(Jul 1970).

The differential cross sections, asymmetry ratios and recoil-nucleon polarizations of pion photoproduction on protons and neutrons below 500 MeV were studied. It is shown that the dispersion theory of Berends, Donnachie and Weaver is unfavorable because of their inadequate treatments of the P_{11} (1470) and D_{13} (1518) resonances. The phenomenological analysis shows that the effect of the Roper P_{11} (1470) resonance is negligible and the isovector amplitude is dominant in the multipole amplitudes leading to the final D_{13} state. The experimental data are also favorably explained by the crude dispersion-theoretical model of Schmidt et al. (auth)

37683 SPLITTING OF THE MAXWELL TENSOR: RADIATION REACTION WITHOUT ADVANCED FIELDS. Teitelboim, Claudio (Univ., Chile, Santiago de Chile). Phys. Rev., D; 1: 1572-82(15 Mar 1970).

It is shown that, for a classical point charge, the "bound" electromagnetic four-momentum contains, besides the generally accepted "Coulomb mass" × four-velocity term, the extra term $-\frac{2}{3}e^2a^\mu$. This is accomplished by exploiting some interesting properties of the usual separation of the retarded field of a moving charge into a velocity and an acceleration part (both retarded). In this way a new derivation of the Lorentz-Dirac equation of motion emerges. In particular, in the light of such a derivation, the physical meaning of the "Schott term" is fully elucidated. The asymptotic condition of uniform motion in the remote past is seen to be essential for the establishment of the differential equation of motion. In contrast with previous discussions, no advanced field need be introduced in any step of the work. Electromagnetic radiation is treated with no single use of asymptotic procedures. Further physical insight is obtained into Rohrlich's criterion for radiation. (auth)

37684 ELECTRODYNAMICS OF CHARGED VECTOR BOSONS. Sheinblatt, M. (Oakland Univ., Rochester, Mich.); Arnowitt, R. Phys. Rev., D; 1: 1603-16(15 Mar 1970).

The interaction of a quantized charged vector boson in the presence of an external electromagnetic field is considered. A nonsingular electromagnetic current operator is obtained by separating the points of the field operators by a small spacelike distance ϵ^μ in a gauge-invariant fashion (analogous to the construction of the current operator of spinor electrodynamics). It is shown that the matrix element of the current is gauge-invariant, divergenceless in the limit $\epsilon^\mu \rightarrow 0$, and no more than logarithmically singular, to all orders of the external electromagnetic field. The resultant theory is seen consequently to be gauge-invariant and to be renormalizable. (auth)

37685 ENERGY LOSS OF HIGH-ENERGY COSMIC RAYS IN PAIR-PRODUCTING COLLISIONS WITH AMBIENT PROTONS. Blumenthal, George R. (Univ. of California, San Diego, La Jolla). Phys. Rev., D; 1: 1596-1602(15 Mar 1970).

General and essentially exact formulas for the energy-loss process $A + \gamma \rightarrow A + e^+ + e^-$ are given for high-energy cosmic-ray nuclei traversing an isotropic radiation field of arbitrary energy spectrum. These formulas are obtained by integrating the appropriate differential cross section in the rest frame of the cosmic-ray particle. Results are then given for the case of a Planckian photon distribution at arbitrary temperature. The effect of

this energy loss on a universal flux of cosmic rays is then investigated along with the possibility that the observed "knee" at high energies is due to pair production. Finally, the energy-loss formula is applied to quasistellar objects, and it is shown that if these objects are at cosmological distances, they are opaque to particles above a certain energy which depends upon the size of the object. (auth)

37686 THEORY OF DEEP-INELASTIC LEPTON–NUCLEON SCATTERING AND LEPTON-PAIR ANNIHILATION PROCESSES. III. DEEP-INELASTIC ELECTRON–POSITRON ANNIHILATION. Drell, Sidney D.; Levy, J.; Yan, Tung-mow (Stanford Univ., Calif.). Phys. Rev., D; 1: 1617-39(15 Mar 1970).

This is the third in a series of four papers devoted to a theoretical study based on canonical quantum field theory of the deep-inelastic lepton processes. The detailed calculations are presented leading to the limiting behavior–or the "parton model"–for deep-inelastic electron-positron annihilation into a nucleon (or hadron) plus "anything else," i.e., $e^- + e^+ \rightarrow p +$ "anything," where "anything" refers to all possible hadrons. In particular, it is shown that the structure functions satisfy a scaling behavior analogous to the Bjorken limit for deep-inelastic scattering. The precise relation of the structure functions for deep-inelastic annihilation processes to those for the deep-inelastic scattering is discussed along with specific experimental implications and tests. (auth)

37687 ASYMPTOTIC BEHAVIOR OF ELECTROPRODUCTION AMPLITUDES FOR ONE HADRON. Matsuda, Satoshi (California Inst. of Tech., Pasadena); Suzuki, Mahiko. Contracts AT (11-1)-68; AS-AFOSR-68-1471. Phys. Rev., D; 1: 1778-81(15 Mar 1970).

The asymptotic behavior for electroproduction of one hadron in the limit $q^2 \rightarrow \infty$ (spacelike) with (laboratory energy)/q^2 large and fixed is derived by means of the Bethe–Salpeter equation, which takes account of the vector property of the photon. (auth)

37688 PHOTOPRODUCTION OF POSITIVE PIONS AT BACKWARD ANGLES IN THE ENERGY RANGE 1 TO 3 GeV. Alvarez, R. A.; Cooperstein, G.; Kalata, K.; Lanza, R. C.; Luckey, D. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Phys. Rev., D; 1: 1946-60(1 Apr 1970).

The cross section for photoproduction of single π^+ from hydrogen was measured at laboratory angles of 110°, 127.5° and 152°, between 0.9- and 3.2-GeV incident photon energy. Measurements have been made with approximately 15% statistical accuracy at about 40 photon energies at each angle. The results agree well with the previous Caltech data of Thiessen. The cross section shows a rapid drop with increasing energy with superimposed bumps or shoulders corresponding to the N(1688), Δ(1920), and Δ(2420). A shallow minimum is observed at the N(2190) resonance. (auth)

37689 SPIN-$\frac{3}{2}$ POLARIZATION IN N^* PHOTOPRODUCTION. Song, H. S. (Seoul National Univ.). Phys. Rev., D; 1: 2031-9 (1 Apr 1970).

The explicit expressions for spin-$\frac{3}{2}$ density-matrix elements are obtained, and a straightforward way to get the decay distribution of a spin-$\frac{3}{2}$ particle is given. The photoproduction $\gamma + p \rightarrow N^{*++} + \pi^-$ and the decay $N^{*++} \rightarrow p + \pi^+$ are considered on the assumption of one axial-vector-meson exchange. The density-matrix elements of N^{*++} contain one parameter which is the ratio of two form factors, and they are compared with the recent experimental data from DESY. A special case of the linearly polarized photon is also considered, and the decay distribution of N^* turns out to be close to the Sakurai-Stodolsky distribution near the threshold. Several other models are also considered and compared with the axial-vector-meson-exchange model. (auth)

37690 REGGE ANALYSIS AND π^0 AND π^+ PHOTOPRODUCTION AT BACKWARD ANGLES. Beaupre, J. V.; Paschos, E. A. (Stanford Univ., Calif.). Phys. Rev., D; 1: 2040-6(1 Apr 1970).

By correlating recent experimental results on π^0 and π^+ photoproduction at backward angles with results on $\pi^- p \rightarrow p\rho^-$ at the same angles, it is found that any explanation of the three processes in terms of Regge poles must involve at least two isospin-$\frac{1}{2}$ trajectories. Furthermore, the two trajectories must be almost degenerate. Such a solution makes definite predictions about other processes which can be checked by experiments. (auth)

37691 EFFECTS OF THE PAULI PRINCIPLE ON THE DOUBLE DALITZ DECAY OF PSEUDOSCALAR MESONS. Hunt, William H. (Coll. of William and Mary, Williamsburg, Va.). Phys. Rev., D; 1: 2116-18(1 Apr 1970).

The differential decay rate for the double Dalitz decay $\pi^0 \rightarrow e^+e^-e^+e^-$ is calculated exactly as a function of the virtual photon masses, with arbitrary form factors at the $\pi^0 - 2\gamma$ vertex. The result is compared with the result of an approximate calculation using only a single Feynman diagram. (auth)

37692 ARGUMENT AGAINST USING THE DIAGONAL FRAME IN TESTS OF VECTOR-MESON DOMINANCE. Donohue, J. T. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., D; 1: 1972-8(1 Apr 1970).

It has been suggested that vector-meson-dominance comparisons of charged-pion photoproduction by polarized photons and vector production by pions be made in the frame where the vector-meson density matrix is diagonal (the Donohue-Högaasen frame). This suggestion is investigated in detail, and it is found that despite the empirical success, the basic idea of vector-meson dominance, that is, a smooth extrapolation in mass, is violated. The suggestion implies that two eigenvalues of the vector-meson density matrix possess a smooth extrapolation in mass to the photon cross sections. But the well-known tendency of eigenvalues to repel each other, plus the experimental fact that ρ-meson production is mainly longitudinal, forces the extrapolation to be violent rather than smooth. The behavior of the eigenvalues is illustrated using the Born model of Cho and Sakurai and a variation thereof. It is concluded, although not proved rigorously, that the apparent success of the comparison using the diagonal frame cannot be used as evidence for the vector-meson-dominance hypothesis. (auth)

37693 CONSEQUENCES OF A $QQ\bar{Q}$ MODEL. III. PHOTOPRODUCTION PROCESSES. Choudhury, D. K. (Univ of Delhi). Phys. Rev., D; 1: 2135-47(1 Apr 1970).

The $QQ\bar{Q}$ model proposed by Mitra is extended to incorporate the photoproduction processes $\gamma B \rightarrow PB$, $\gamma B \rightarrow PB^*$, $\gamma B \rightarrow VB$, and $\gamma B \rightarrow VB^*$ through a formulation of the basic mechanisms $VQ \rightarrow VQ$ and $VQ \rightarrow PQ$, where P and V denote the pseudoscalar and vector mesons, and B and B^* denote the octet and decuplet baryons, respectively. The consequences of this model are then investigated through the cross-section sum rules for various processes and the density-matrix analysis of the photoproduced B^* or V. Clean geometrical results are obtained for the density matrices of B^* for the processes of the type $\gamma B \rightarrow PB^*$ in the forward direction; these results agree well with the recent experimental data. A prediction for the corresponding angular distributions is also presented under the assumption of dominance of (–) amplitudes, which represent the transitions between the negative-parity $QQ\bar{Q}$ states. For all processes of the type $\gamma B \rightarrow VB$, for any angle ϕ, $\rho^V_{1-1} = 0$ is obtained. Angular distributions of the other density-matrix elements of the vector mesons for such processes are obtained under the following assumptions: (i) $Q\bar{Q}$ forces are spin- and unitary-spin-independent and operate mainly through the s wave, and (ii) production processes are dominated by the (–) amplitudes. The agreement with experiment is again fairly good. A sum rule of the form $\rho^V_{10} = (8/3)\rho^D_{33}$ is obtained in the forward direction relating the density matrix of the vector meson with that of the decuplet baryon for all processes of the type $\gamma B \rightarrow VB^*$. Cross-section sum rules for various processes are also presented and compared with experiment. (auth)

37694 PION ELECTROMAGNETIC FORM FACTOR IN A VENEZIANO-TYPE REPRESENTATION. Chia, T. C.; Hama, M.; Kiang, D. (Dalhousie Univ., Halifax, Can.). Phys. Rev., D; 1: 2126-30(1 Apr 1970).

A simple form of the pion electromagnetic form factor F(s) in a Veneziano-type representation is investigated. The derivation of this form factor makes use of Martin's μ plane in which the four-point Veneziano amplitude is represented by a single moving pole. The pion form factor thus obtained contains only one parameter. Using only unitarity near the threshold, this parameter can be determined. The result is $F(s) \sim s^{-1.5}$ in the spacelike region and $|F(s)|^2 \simeq 59$ at $s \simeq m_\rho^2$, in reasonable agreement with the experimental data. Finally, the hypothesis that the Pauli-Dirac isovector form factor of the nucleon may be identified with the pion form factor is checked. The agreement with data is good. (auth)

37695 PION ELECTROMAGNETIC FORM FACTOR AND THE VENEZIANO MODEL. Amatya, A.; Taha, M. O. (International Centre for Theoretical Physics, Trieste, Italy). Phys. Rev., D; 1: 2147-51(1 Apr 1970).

Elastic unitarity is used to connect the pion electromagnetic form factor to the ππ Veneziano amplitude. A model for the form factor exhibiting this connection is obtained. It is in fair agreement with experiment. (auth)

37696 MINIMAL GAUGE-INVARIANT ONE-VECTOR-MESON-EXCHANGE MODEL FOR ASSOCIATED Δ AND CHARGED ρ PHOTOPRODUCTION. Clark, Robert Beck (Univ. of Texas, Austin). Phys. Rev., D; 1: 2152-5(1 Apr 1970).

A gauge-invariant one-vector-meson-exchange (OVE) model

is constructed for the process $\gamma + N \rightarrow \rho^s + \Delta$. The form of the model is obtained by selecting the simplest extension of the OVE diagram consistent with gauge invariance. The $\Delta\rho N$-coupling strength is considered and discussed in terms of vector-meson dominance. It is found that the interference between the OVE and one-pion-exchange amplitudes vanishes. (auth)

37697 PHOTON–PHOTON SCATTERING CONTRIBUTION TO THE SIXTH-ORDER MAGNETIC MOMENTS OF THE MUON AND ELECTRON. Aldins, Janis (Cornell Univ., Ithaca, N. Y.); Brodsky, Stanley J.; Dufner, Andrew J.; Kinoshita, Toichiro. Phys. Rev., D; 1: 2378-95(15 Apr 1970).

The three-photon exchange contribution to the sixth-order anomalous magnetic moment of the leptons was calculated. The result for the electron-loop contribution to the muon moment $(18.4 \pm 1.1)(\alpha/\pi)^3$ brings the theoretical prediction into agreement with the CERN measurements within the 1-standard-deviation experimental accuracy. The result for the electron-loop contribution to the electron moment is $(0.36 \pm 0.04)(\alpha/\pi)^3$. The theoretical errors represent the accuracy of the required seven-dimensional numerical integrations. (auth)

37698 CHARGE QUANTIZATION, COMPACTNESS OF THE GAUGE GROUP, AND FLUX QUANTIZATION. Yang, C. N. (State Univ. of New York, Stony Brook). Contract AT(30-1)-3668B. Phys. Rev., D; 1: 2360(15 Apr 1970).

The relationship between charge quantization and the compactness of the gauge group is discussed. Also, remarks are made about charge quantization and the observation of flux quantization in superconductors. (auth)

37699 NUCLEAR-ELECTROMAGNETIC CASCADES IN GLASS, IRON, AND TUNGSTEN ABSORBERS. Jones, W. V. (Louisiana State Univ., Baton Rouge). Phys. Rev., D; 1: 2201-11(15 Apr 1970).

Results of a Monte Carlo simulation of the longitudinal development of nuclear-electromagnetic cascades in glass, iron, and tungsten absorbers are presented. The simulation was fitted first to measurements made with an iron-absorber ionization spectrometer that was exposed at an accelerator to protons of known energies. The calculations were then extended to higher primary energies and to the other two absorbers. The results presented are for the energy range 10 to 1000 GeV. The maximum absorber depths considered are 56, 96, and 192 radiation lengths for glass, iron, and tungsten, respectively. Average cascade development curves and their fluctuations, as well as the ionization energy deposited by the cascades, are given as a function of the absorber depth. The accuracies with which the cascades can be used to determine unknown primary energies are also presented. It is shown that these accuracies increase rapidly with the total absorber depth up to an optimum depth for a given primary energy and given absorber. Over the energy range considered and for moderately large absorber depths, the accuracy also improves with increasing primary energy. (auth)

37700 RADIATIVE CORRECTION TO EIKONAL FUNCTIONS IN ELECTRODYNAMICS. Yao, York-peng (Univ. of Michigan, Ann Arbor). Phys. Rev., D; 1: 2316-27(15 Apr 1970).

It is shown that the second-order radiative correction changes the electron eikonal function into $[1 + F(k^2)] \times [1 + F'(k^2)]E(k^2)$, where $E(k^2)$ is the bare eikonal, k is the momentum transfer between the electrons (e and e'), and $F(k^2)$ is the second-order electric form factor. This suggests that in high-energy near-forward electrodynamic processes, the eikonals should be regarded as the basic carriers of the interaction. (auth)

37701 REGGEIZED U(6) ⊛ U(6) ⊛ O(3) AND THE ABSORPTION MODEL FOR $\gamma p \rightarrow \pi^+ n$. Collins, P. A ; Hartley, B. J.; Jenkins, J D.; Moore, R. W.; Moriarty, K. J. M. (Imperial Coll. of Science and Tech., London). Phys. Rev., D; 1: 2619-25(1 May 1970).

Preliminary results on the application of the Reggeized U(6) ⊛ U(6) ⊛ O(3) absorptive peripheral model to photoproduction reactions are presented, with a detailed treatment for $\gamma p \rightarrow \pi^+ n$. The agreement of the theory with experiment is most encouraging.(auth)

37702 FORWARD CHARGED-PION ELECTROPRODUCTION FROM FIXED-MOMENTUM-TRANSFER DISPERSION RELATIONS. Berends, F. A. (Harvard Univ., Cambridge, Mass.). Contract AT(30-1)-2076. Phys. Rev., D; 1: 2590-4(1 May 1970).

The s-channel approach to forward charged-pion photoproduction above the resonance region by means of fixed-t dispersion relations is known to be quite successful. The kind of behavior that can be expected for charged-pion electroproduction is investigated on the basis of such a model. (auth)

37703 PION–PION SCATTERING INFORMATION FROM $e^-e^+ \rightarrow \pi^-\pi^+\gamma$. Creutz, M. J.; Einhorn, M. B. (Stanford Univ., Calif.). Phys. Rev., D; 1: 2537-46(1 May 1970).

It is shown how the reaction $e^-e^+ \rightarrow \pi^-\pi^+\gamma$ can be used to study the dipion system in states of even charge conjugation (and even angular momentum). In particular, its utility for experimentally investigating an I = 0, J = 0 resonance (ε meson) is discussed in detail. (auth)

37704 EXOTIC STATES AND PHOTOPRODUCTION FROM DEUTERIUM. Dar, Arnon (Technion-Israel Inst. of Tech., Haifa); Gal, Avraham. Phys. Rev., D; 1: 2714-15(1 May 1970).

Recent data on photoproduction from deuterium, which have been proposed as evidence for t-channel exchange of exotic meson states, are examined. It is shown that the effects that were associated with exchange of exotic states can result from shadow effects in the deuteron. (auth)

37705 LOGARITHMIC FACTORS IN THE HIGH-ENERGY BEHAVIOR OF QUANTUM ELECTRODYNAMICS. Cheng, Hung (Massachusetts Inst. of Tech., Cambridge); Wu, Tai Tsun. Phys. Rev., D; 1: 2775-94(15 May 1970).

The perturbation series for electron-electron elastic scattering in quantum electrodynamics is studied in the limit of high energies. For this matrix element, in addition to the previously known terms which are proportional to s (the square of the c.m. energy) and hence lead to a constant total cross section at high energies, there are found terms of the orders of magnitudes $s \ln s$, $s (\ln s)^2$, $s (\ln s)^3$, etc. For n = 1, 2, 3, . . ., the coefficient of $s (\ln s)^n$ is a power series in the fine-structure constant α, where the leading term is proportional to $\alpha^{2(n+1)}$ and is due to Feynman diagrams with n closed electron loops. Physically, through the optical theorem, the presence of these terms is intimately related to the production of low-energy electron-positron pairs in high-energy electron-electron scattering, but is independent of whether the spin-1 particle is a photon with zero mass or massive neutral vector meson. These leading terms of order $\alpha^{2(n+1)}$ are explicitly found for all n, and are all imaginary, representing absorption. The procedure of summing the leading term is carried out, and the result demonstrates dramatically the importance of unitarity in the direct. or s, channel for high-energy processes. Generalization to two-body diffraction processes $a + b \rightarrow a' + b'$ is immediate. (auth)

37706 ELECTROPRODUCTION STRUCTURE FUNCTIONS, INTEGRAL REPRESENTATIONS, AND LIGHT-CONE COMMUTATORS. Brandt, Richard A. (Rockefeller Univ., New York). Phys. Rev., D; 1: 2808-23(15 May 1970).

The electroproduction inelastic structure functions $W_i(\kappa,\nu)$ $(i = 1,2; \kappa = q^2 =$ momentum transfer squared; $\nu = q \cdot p =$ energy transfer; $p^2 = 1)$ are studied in the Bjorken (A) limit ($\nu \rightarrow \infty$, $\rho \equiv -\nu/\kappa$ fixed) and in the Regge (R) limit ($\nu \rightarrow \infty$, κ fixed). Finite A limits $[F_2(\rho) = \lim \nu W_2(\kappa,\nu)$, $F_1(\rho) = \lim W_1(\kappa,\nu)]$ and Pomeranchuk-dominated R limits $[w^2(\kappa)\nu^{-1} = \lim W_2$, $w_1(\kappa)\nu = \lim W_1]$ are assumed. These two limits are first related by use of Deser–Gilbert–Sudarshan (DGS) representations for causal functions $V_i(\kappa,\nu)$ related to the W_i by $W_2 = \kappa V_2$ and $W_1 = \kappa V_1 - \nu^2 V_2$. The above A- and R-limit assumptions, together with a smoothness assumption on the DGS spectral functions motivated by the existence of equal-time commutators, are shown to imply that $F_2(\infty) = w_2(-\infty) \equiv w_2 =$ const and $\lim_{\rho\rightarrow\infty} F_1(\rho)/\rho = -\lim_{\kappa\rightarrow\infty} w_2(\kappa)\kappa \equiv w_1 =$ const. These results agree with experiment if $w_1 \neq 0$. The properties of the spectral functions that are obtained are used to discuss some equal-time commutators and properties of the photon structure function and the cross section $\sigma_\gamma(\nu)$. The empirical value of $\sigma_\gamma(\infty)$ is used to roughly calculate w_2. It is stressed, however, that the above assumptions do not preclude the possibility that $w_2 = 0$. The Fourier transforms $\hat{W}_i(x^2, p\cdot x)$ of the $W_i(\kappa,\nu)$ are next studied and used to again relate the A and R limits. Restrictions on the W_i imposed by the requirements of finite A limits and correct R limits are determined and results equivalent to the above ones are obtained. This analysis determines the configuration-space behavior corresponding to the A and R limits for large ρ and κ, respectively. These limits are shown to determine the behavior of the $\hat{W}_i$ near the light cone $x^2 = 0$, and the results are that $\pi\hat{W}_2 \sim \delta(x^2)^{1/2}\epsilon(x_0)\hat{I}_2(x_0)$ and $\pi\hat{W}_1 \sim \delta'(x^2)2|x_0|\hat{I}_1(x_0)$ for $x^2 \sim 0$, where $w_2 = \frac{1}{2}i\int dx_0\, \hat{I}_2(x_0)$ and $w_1 = 2i[\hat{I}_1(\infty) - \hat{I}_1(-\infty)]$. Corresponding properties of the V_i are derived, and the equivalence of this approach with the one using integral representations is established. The light-cone behavior of each component of $\langle p|[J_\mu(x), J_\nu(0)]|p\rangle$ can be determined, and it is shown in particular that $\langle p|[J_0 - J_3, J_0 - J_3]|p\rangle \sim \delta(x^2)\epsilon(x_0)\hat{I}_2(x_0)$, apart from total derivatives with respect to $x_3 - x_3$. The light-cone behavior equivalent to the Fubini–Dashen–Gell-Mann sum rule is then put in a form which can accommodate this result so well that we are led to propose a highly symmetric universal structure for the light-cone commutator of two SU(3) currents. The universality is made precise by use of the $SU(3) \otimes SU(3)_A$ equal-time commutation relations. The equal-time implications of the proposal are considered and are shown

to be consistent with, and suggested by, the gluon mode. In the context of this model, w_2 is numerically estimated and found to agree with the experimental value. (auth)

37707 RADIATIVE CORRECTIONS TO THE $e^-e^\pm$ SCATTERING AMPLITUDE AT INFINITE ENERGY. Chang, Shau-jin (Univ. of Illinois, Urbana). Phys. Rev., D; 1: 2977-9(15 May 1970).

In the high-energy limit of ee elastic scattering, as given by all possible multiphoton exchanges, a large class of radiative corrections is considered. This class of radiative corrections is one in which one ignores processes involving pair creations and annihilations. The resultant amplitude is found to be proportional to the square of the c.m. energy, multiplied by the product of the e.m. form factors and the eikonal form. (auth)

37708 NONEQUILIBRIUM EFFECTS AND THE COMPTON ENERGY EXCHANGE. Alexanian, M. (Univ. of California, Livermore). Nuovo Cim.; 68B: 11-22(11 Jul 1970).

It is shown that for given radiation energy a Planckian photon spectrum gives the maximum rate of energy exchange between electrons and photons due to Compton scattering. (auth)

37709 HIGH-ENERGY PHOTOPRODUCTION OF π^0 AND η MESONS AND THE DIP PROBLEM. Colocci, M. (CERN, Geneva). Lett. Nuovo Cim.; 4: 53-60(11 Jul 1970).

An explanation for the difference between the shape of the π^0 and η differential cross sections is given in terms of the class of theories in which the dip mechanism is attributed to interference between the pole terms and the cut terms. A simple model is formulated for calculating cut corrections to Regge-pole exchanges directly in terms of S-channel helicity amplitudes. Good fits were obtained to the π^0 and η photoproduction data in a large range of energies and momentum transfers. (L.B.S.)

37710 DENSITY EFFECT IN THE IONIZATION ENERGY LOSS OF FAST CHARGED PARTICLES IN MATTER. Crispin, A. (Northern Polytechnic, London); Fowler, G. N. Rev. Mod. Phys.; 42: 290-316(Jul 1970).

Recent experimental work and its theoretical interpretation concerned with the density effect on the energy loss of charged particles in matter is reviewed with particular reference to electrons and muons. Recent proposals that radiative corrections should result in a significant reduction in the ionization loss at very high energies are analyzed in some detail. It is concluded that such an effect has not been substantiated experimentally, and that the predicted radiative corrections are likely to be small (~1%). (auth)

37711 TRANSITION RADIATION, CHERENKOV RADIATION, AND ENERGY LOSSES OF RELATIVISTIC CHARGED PARTICLES TRAVERSING THIN FOILS AT OBLIQUE INCIDENCE. THEORETICAL CALCULATIONS AND NUMERICAL COMPUTATIONS. Kroeger, Erhard (Univ., Hamburg). Z. Phys.; 235: 403-21(1970).

Semiclassical relativistic energy losses and the transition radiation are calculated for fast charged particles (e.g., electrons) traversing a thin dielectric foil at oblique incidence. The transition radiation formula is generalized for foils with spatial dispersion. This formula for oblique electron incidence is of particular interest for the observation of Čerenkov radiation, emitted from a dielectric foil. The emission of Čerenkov radiation is discussed for varying electron incidence angle and foil thickness by the aid of numerical computations. (auth)

37712 RADIATIVE CORRECTIONS TO THE PROCESS $e^+ + e^- \rightarrow \pi^0 + \gamma$. Gakh, G. I. (Physical-Technical Inst., Kharkov). Ukr. Fiz. Zh.; 15: 798-803(May 1970). (In Russian).

Radiative corrections to the process $e^+ + e^- \rightarrow \pi + \gamma$ are calculated in the twice-logarithmic approximation with taking into account radiation of soft photons. (auth)

37713 COMMUTATORS OF CURRENT-DENSITY OPERATORS: ASYMPTOTIC EXPANSION WITH FIXED NEGATIVE PHOTON MASS SQUARED. Ruehl, W. (CERN, Geneva). Nuovo Cim.; 68A: 235-57(21 Jul 1970).

A group-theoretical approach to the $O_{3,1}$ analysis of commutators of conserved and nonconserved currents is presented. (auth)

37714 RESONANCE INTERACTION BETWEEN AN INTENSIVE PHOTON FLUX AND A BOUND ELECTRON AND THEORY OF THE TIME DELAY. Perel'man, M. E. (Inst. of Cybernetics, Tbilisi, USSR). Zh. Eksp. Teor. Fiz.; 58: 2139-46(Jun 1970). (In Russian).

Stimulated emission and elastic scattering of resonance photons in a two-level system are calculated by quantum electrodynamics and scattering theory methods by taking into account absorption and re-emission of the incident quanta. The rates of the reactions possess a saturation threshold with respect to the photon flux density $j_0 \sim 1/\lambda^2\tau$ where τ is the duration of an elementary scattering act. It is shown that new reaction channels may open up not as a result of increase of energy of the scattered particle but as a result of increase of flux density of the incident particles. An experimental investigation of these features (and also of the lower and higher limits of the monochromaticity region of stimulated radiation) may help to elucidate the problem of the existence and magnitude of the time delay. (auth)

37715 ELECTROMAGNETIC MASS DIFFERENCE OF ZERO-MASS PIONS: FOURTH ORDER. Gerstein, Ira S. (Massachusetts Inst. of Tech., Cambridge); Schnitzer, Howard J.; Wong, Tang-fong; Guralnik G. S. Contracts AT(30-1)-2098; AT(30-1)-3178. Phys. Rev., D; 1: 3442-52(15 Jun 1970). (NYO-2262-TA-198).

The fourth-order contribution to the electromagnetic mass difference of zero-mass pions is considered in a model whose high-energy behavior is that given by algebra-of-fields commutation relations. This quantity is found to be logarithmically divergent. Possible sources of this divergence are discussed. (auth)

37716 EQUIVALENCE OF THE DIRAC EQUATION TO A SUBCLASS OF FEYNMAN DIAGRAMS. Dittrich, Walter (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Phys. Rev., D; 1: 3345-8(15 Jun 1970).

The Dirac equation of an electron in a Coulomb field is shown to be equivalent to a certain subclass of Feynman diagrams taken within the eikonal approximation. The result is obtained via analysis of a two-body scattering amplitude, wherein the role of the heavier of the two particles involved is to generate the effective external potential in which the lighter particle propagates. The poles of the scattering amplitude are found to be the well-known relativistic binding energies. (auth)

37717 PLANE-WAVE PACKETS AND THEIR LIMITATION IN NONLINEAR COMPTON SCATTERING. Dawson, John F. Univ. of New Hampshire, Durham); Fried, Zoltan. Phys. Rev., D; 1: 3363-70(15 Jun 1970).

It is shown that scattering boundary conditions are incompatible with a monochromatic radiation field for the case of nonlinear Compton scattering. This is demonstrated by showing that (a) in the monochromatic limit, gauge invariance in a given order of the expansion of the S matrix is destroyed, and (b) the physical (scattering) boundary condition, that of a pulse of radiation incident on a target electron, cannot be reconstructed from the monochromatic limit of the S matrix. It is then shown by an example that the frequency profile of the scattered radiation is a function of both the intensity and line shape of the incident field. Another interesting feature of this calculation is that the profile of the photon scattered at a fixed angle is significantly broadened in comparison with the incident line shape. The worked-out example is a simple model, that of a neutral, scalar "electron" interacting with a bilinear scalar, massless external field, which contains all the important features of nonlinear Compton scattering. While from the point of view of gauge invariance it is sufficient to treat the external radiation field as a one-dimensional wave packet, for a complete description of the problem it is necessary to describe the incident radiation (quanta) in terms of normalizable states. An estimate of the breakdown of the plane-wave approximation is included. (auth)

37718 PHOTON–PHOTON SCATTERING CLOSE TO THE FORWARD DIRECTION. Cheng, Hung (Massachusetts Inst. of Tech., Cambridge); Wu, Tai Tsun. Phys. Rev., D; 1: 3414-15 (15 Jun 1970).

The scattering amplitude for photon–photon elastic scattering in quantum electrodynamics is explicitly obtained for the case where the energy is very large while the momentum transfer is small compared with the rest energy of the electron (divided by c). This amplitude has no infrared divergence and, at high energies, the fourth- and sixth-order contributions are negligible. The explicit answer for the eighth order is remarkably simple. In terms of helicity states, it is found that the amplitudes RR → RR and RL → RL are the same, while the amplitude RR → LL is different but of the same order of magnitude. By the optical theorem, the total cross section for $\gamma + \gamma \rightarrow e^- + e^- + e^+ + e^+$ is found to be 6.5 μb at high energies. (auth)

37719 REMARKS ON ELECTROMAGNETIC MASS DIFFERENCES. Nagylaki, Thomas (Univ. of Colorado, Boulder). Phys. Rev., D; 1: 3517-19(15 Jun 1970).

An O(4,2) model for the electromagnetic transitions of the $I = 1/2$ nucleon resonances is inserted into a finite-energy sum rule for forward off-shell Compton scattering in order to estimate the neutron–proton mass splitting. The result is encouraging. Comments are made on the importance of the nonpole terms

and of the high-momentum-transfer behavior of the form factor in the case of the pion mass difference. (auth)

37720 MASS SPLITTING DOMINATED BY THE TENSOR-MESON TRAJECTORIES. Horwitz, L. P. (Univ. of Denver); Kantorovich, Aharon. Phys. Rev., D; 1: 3520-1(15 Jun 1970).

A connection between an idea of Dashen's concerning SU(3) mass splitting and a similar treatment based upon the algebraic approach of Cabibbo, Horwitz, and Ne'eman is pointed out. Comment is also made on results obtained recently by Buccella et al. concerning hadron electromagnetic mass splittings. (auth)

37721 ROLE OF THE REPULSIVE CORE IN THE $^3S_1$ POTENTIAL AND THE ELECTROMAGNETIC FORM FACTORS OF THE DEUTERON. Mehrotra, Rashmi; Sen Gupta, Krishna (Univ. of Delhi). Phys. Rev., D; 1: 3459-65(15 Jun 1970).

The deuteron wave function at short distances is investigated by assuming three types of input separable potentials: (i) central + repulsive core, (ii) central + tensor, (iii) central + tensor + repulsive core (C + T + H). The wave function is parametrized through a fit to the $^3S_1$ phase shifts and the deuteron parameters. A detailed comparison with experiment of the electromagnetic form factors of the deuteron, calculated with the above three types of potentials, clearly indicates the importance of the repulsive core in the two-nucleon system. The best results, obtained with the C + T + H potential, give very good agreement with experimental values. Inclusion of Shirokov's relativistic corrections in the basic input potential improves the results still further. (auth)

Weak

Refer also to abstracts 37838, 37840, 37842, and 38354.

37722 (UR-875-310) BROKEN CHIRAL SYMMETRY AND CORRECTIONS TO SOFT PION THEOREMS. Mathur, V. S.; Okubo, S. (Rochester Univ., N. Y. Dept. of Physics and Astronomy). 19 Jun 1970. Contract AT(30-1)-875. 12p. (CONF-700806-6). Dep. CFSTI.

From 15th International Conference on High Energy Physics, Kiev, USSR.

On the basis of the model of Gell-Mann, Oakes and Renner, it has been found that the points a = −1, 0, and 2 correspond to the exact validities of the SW(2), ordinary and chimeral SU(3) subgroups, respectively where a is the symmetry breaking parameter of the theory. Noting that at a = −1 and 2, the pion and kaon respectively become zero mass particles, on the basis of a smoothness assumption a simple way of evaluating corrections to the soft pion results is proposed. Especially, applications to K_{l3}, non-leptonic decays, and the Goldberger–Treiman relation are discussed. (auth)

37723 RADIATIONAL SCATTERING OF NEUTRINOS OVER LEPTONS. Mukhtarov, A. I.; Nagizhafov, I. M.; Abdullaev, S. K. (Azerbaidzhan State Univ., Baku). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 4, 69-73(1970). (In Russian).

A process of $\nu_l(\bar{\nu}_l) + l \rightarrow \nu_l(\bar{\nu}_l) + l + \gamma$ was studied considering the polarization of particles. A universal expression was found for the differential effective cross section, energy, and angular distribution of electron recoil, and for circular and linear polarization of γ-quanta. (R.V.J.)

37724 LIMIT ON THE INDUCED PSEUDOTENSOR FORM FACTOR OF THE AXIAL-VECTOR CURRENT. McKellar, Bruce H. J. (Univ. of Sydney). Phys. Rev., D; 1: 2183(1 Apr 1970).

The sign of the observed circular polarization of γ rays emitted by nuclei is used to show that, in the Cabibbo theory of the weak interaction, the induced pseudotensor form factor of the axial-vector current satisfies the inequality $-2 < f_T(0)/f_A(0)$. (auth)

37725 $K^+ \rightarrow \pi^+ + \nu^+\bar{\nu}$ BRANCHING RATIO. Willey, R. S. (Univ. of Pittsburgh). Contract AT(30-1)-3829. Phys. Rev., D; 1: 2182-3(1 Apr 1970).

An upper bound for the branching ratio for the decay $K^+ \rightarrow \pi^+\nu\bar{\nu}$ is estimated in the conventional theory with no neutral currents. (auth)

37726 APPLICATIONS OF CURRENT COMMUTATION RELATIONS TO MUON CAPTURE AND NEUTRINO (ANTINEUTRINO) REACTIONS IN NUCLEI. Kim, C. W. (Johns Hopkins Univ., Baltimore); Ram, Michael. Phys. Rev., D; 1: 2651-62(1 May 1970).

Relations among total muon-capture rates in nuclei and the equal-time commutators of the space and time components of the strangeness-conserving weak hadron current are derived. Using the quark field algebra and the closure approximation, this relation yields a total muon-capture rate in ^3He of $\Gamma(^3He) \approx 2.36 \times 10^3$ sec^{-1}, in very good agreement with experiment. It is demonstrated that application of the gauge field algebra does not yield a result that can be compared with experiment, since the use of the closure approximation cannot be justified in the context of this algebra. Using the quark field algebra and the closure approximation, similar relations are also derived for the total "elastic" differential cross section for forward scattering of neutrinos off nuclei. (auth)

37727 THEORY OF DEEP-INELASTIC LEPTON–NUCLEON SCATTERING AND LEPTON PAIR ANNIHILATION PROCESSES. IV. DEEP-INELASTIC NEUTRINO SCATTERING. Yan, Tung-mow; Drell, Sidney D. (Stanford Univ., Calif.). Phys. Rev., D; 1: 2402-13(15 Apr 1970).

This is the last in a series of four papers devoted to a theoretical study based on canonical field theory of the deep-inelastic lepton processes. The detailed calculations, leading to the limiting behavior—or the "parton model"—for deep-inelastic neutrino scattering, i.e., $\nu + p \rightarrow e^- +$ "anything," $\bar{\nu} + p \rightarrow e^+ +$ "anything," where "anything" refers to all possible hadrons are presented. In particular, it is shown that the structure functions depend only on the ratio of energy to momentum transfer $2M\nu/q^2$ as conjectured by Bjorken on general grounds. Experimental implications, including sum rules and the relation of ν and $\bar{\nu}$ cross sections to each other as well as to deep-inelastic scattering cross sections, are derived and discussed. (auth)

37728 MESON FORM FACTORS AND THE VENEZIANO MODEL. Tokuda, Naoki; Oyanagi, Yoshio (Tokyo Univ.). Phys. Rev., D; 1: 2626-30(1 May 1970).

The K_{l4}, K_{l3}, and K_{l2} form factors, as well as the pion electromagnetic form factor, are derived from the matrix element $\langle\pi|A_\mu|\pi K\rangle$ by using partial conservation of axial-vector current, current algebra, and the field-current identity, in addition to the Veneziano representation for the scattering amplitudes. This model contains essentially only one free parameter, by which all the quantities are expressed. The results agree with the present experimental data excellently. (auth)

37729 NONLEPTONIC HYPERON DECAYS. Shimada, Junichi; Bludman, Sidney (Univ. of Pennsylvania, Philadelphia). Phys. Rev., D; 1: 2687-95(1 May 1970).

Suzuka and Sugawara's theory of S-wave nonleptonic hyperon decay is reviewed to see to what extent their theory tests current algebra and the current × current form of interaction. The only argument for the current × current form in nonleptonic decays that it is all compelling is the vanishing of the S-wave amplitude $A(\Sigma\ddagger)$ for the decay $\Sigma^+ \rightarrow n + \pi^+$. For the P-wave decay, to which the soft-pion formalism is inapplicable, an octet pole model is used. To fit the empirical P-wave amplitudes, strong-coupling shifts are required in both the S and the P waves. Including SU(3) symmetry breaking leads to parity-violating Born terms in the S waves; to estimate the parity-violating spurion coupling, the kaon tadpole model and $K_2\pi$ decay rate are used. If pionic and kaonic strong-coupling constants are suppressed by ⅔ and ⅓, all the S- and P-wave amplitudes are given within 20%, but $A(\Sigma\ddagger)$ now does not precisely vanish. If $A(\Sigma\ddagger) = 0$ exactly is insisted on, then the suppression of pionic strong-coupling constants by ⅔ and ⅓ is necessary. (auth)

37730 WEAK-INTERACTION MODEL WITH FINITE SELF-MASSES OF LEPTONS. Terazawa, Hidezumi (Tokyo Univ.). Phys. Rev., D; 1: 2950-4(15 May 1970).

A model of the weak interactions is proposed for leptons, including scalar intermediate bosons $C^\pm$ with a negative metric in addition to the usual weak vector bosons $B^\pm$. With this modification, problems of divergence and high-energy behavior are greatly reduced. If the logarithmic weak and electromagnetic self-mass divergences are assumed to cancel each other, the coupling constant g and the mass m_B (=m_C) of the weak boson are predicted to be $g^2 = \frac{3}{2}e^2$ and $m_B = 137.7m_p$ ($\approx m_p/\alpha$) (where m_p is the proton mass), respectively. The finite self-masses are $\delta m_l \simeq (3e^2/16\pi^2)m_l \ln(m_B/m_l)^2$ ($\approx 0.044m_e$ for an electron). It is shown that the renormalization of both the electromagnetic and weak interactions can be consistently accomplished in spite of the existence of the parity-violating interaction. The contributions of the weak interaction to the anomalous magnetic moments of leptons are calculated to be $\frac{1}{2}(g_l - 2) = -Gm_l^2/12\sqrt{2}\pi^2$ ($\simeq -7.7 \times 10^{-10}$ for μ). Various weak reactions of leptons are discussed. For example, $\sigma(\nu_\mu + e \rightarrow \mu + \nu_e)$ approaches a constant value $G^2m_B{}^2/\pi \simeq 2.8 \times 10^{-34}$ cm^2 at high energies. (auth)

37731 NEUTRINO ELECTROMAGNETIC FORM FACTOR IN A RENORMALIZABLE SCALAR-BOSON-EXCHANGE MODEL. Chaudhuri, R. N.; Dutt, Ranabir (Univ. of Delhi). Phys. Rev., D; 1: 2945-9(15 May 1970).

The electromagnetic properties of the neutrino in the presence of weak interactions are studied using the two-scalar-boson-exchange model due to Kummer and Segrè. The logarithmically divergent

amplitudes of the lowest-order Feynman diagrams are regularized by means of the usual renormalization procedure. The numerical results, such as the charge radius of the neutrino, turn out to be of the same order as those of the previous calculations by Bernstein and Lee based on the intermediate-vector-boson theory. (auth)

37732 POSSIBLE EXTENSION OF MINIMAL CURRENT ALGEBRA AND APPLICATIONS. Mohapatra, R. N. (State Univ. of New York, Stony Brook). Contract AT(30-1)-3668B. Phys. Rev., D; 1: 2930-3(15 May 1970).

An attempt was made to extend the minimal current algebra of Bjorken and Brandt starting from a gauge-field Lagrangian and including in it nonets of scalar and pseudoscalar fields and making use of canonical commutation relations both for spin-zero and spin-one fields. To apply it to the problem of weak-interaction divergences, suitably normalized fields with weak currents and scalar and pseudoscalar densities introduced by Gell-Mann are identified. As in the case of Bjorken and Brandt, the limit $m_0 \to 0$, $g_0 \to 0$ is taken such that $g_0/m_0^2 = \text{const} \neq 0$, where m_0 and g_0 are masses and coupling constants of the Yang-Mills field. In the extended minimal algebra, the nonleptonic weak processes are free of all divergences to lowest order and of a class of leading divergences to all orders in the weak-coupling constant. (auth)

37733 A NOTE ON ADLER'S TEST FOR CVC IN WEAK INTERACTIONS. Mani, H. S. (Indian Inst. of Tech., Kanpur). Lett. Nuovo Cim.; 4: 45-7(11 Jul 1970).

Adler's theorem is proved for reactions of the form $\nu_l + \alpha \to l^- + \pi^- + \beta'$, including one-photon exchange from the $(\pi^+ l^- \nu)$ system to the $(\alpha\beta')$ system, where α and β are hadrons and $\alpha \neq \beta$. It is pointed out that the result holds only for a coherent single-pion omission. (L.B.S.)

37734 WEAK PCAC AND K_{l3} FORM FACTORS. Brandt, R. A.; Preparata, G. (Rockefeller Univ., New York). Lett. Nuovo Cim.; 4: 80-5(11 Jul 1970).

The K_{l3} form factors are studied using a weak version of PCAC in the context of the symmetry-breaking pattern $SU_3 \times SU_3 \to SU_3 \to SU_2$. (L.B.S.)

37735 MODEL FOR WEAK INTERACTIONS WITH INTERMEDIATE SPINLESS BOSONS. Lord, E. A. (Univ. of Durham, Eng.). Nuovo Cim.; 68A: 184-202(21 Jul 1970).

A scheme for the weak interactions is outlined in which the intermediate bosons W are spinless. The model possesses an SU_3 symmetry with nine bosons belonging to a sextet and triplet representation. The absence of $\Delta T = 3/2$ and $\Delta Y = 2$ nonleptonic processes is a natural consequence of the form of the interaction. The second-order Lagrangian that arises from interchange of the bosons consists of two parts. One of these is the coupling of a charged current to its Hermitian conjugate, as in the usual theory, and the other is the coupling of two neutral V–A currents to each other, one of which has the property that its vector part is the electromagnetic current. (auth)

37736 THEORY OF WEAK INTERACTIONS WITHOUT DIVERGENCES. Fivel, D. I.; Mitter, P. K. (Univ. of Maryland, College Park). Phys. Rev., D; 1: 3270-90(15 Jun 1970).

A theory of weak interactions is suggested which is free of the divergences associated with the four-fermion theory and the usual intermediate-vector-boson theory, without the use of cutoffs. The interaction Lagrangian is a universal, local coupling of the usual weak currents to a vector field operator which is a nonentire function of a minimal set of vector-meson fields of large mass ($\gtrsim$5 GeV). A summation procedure related to that of Efimov and Fradkin is developed for the analysis of such Lagrangians, and S-matrix elements are computed thereby. It is shown that the (two) parameters of the Lagrangian may be adjusted to produce finite fermion self-energies and finite second- and fourth-order graphs. A power-counting argument is given that this finiteness then persists to all orders without the use of cutoffs. It is further shown that the parameters may be chosen to produce agreement with the predictions of the Fermi theory at low-energies and momentum transfers. The high-energy deviations from Fermi theory predicted by this theory are analyzed. The problem of ambiguities associated with nonpolynomial Lagrangians is discussed. A prescription for the resolution of the ambiguity is given which is expected to ensure the unitarity of the theory in all orders. (auth)

Strong (General)

Refer also to abstracts 37757, 37813, 37885, and 37954.

37737 (CALT-68-260) QUARK SPIN AND DUALITY. Carlitz, R.; Ellis, S.; Freund, P. G. O.; Matsuda, Satoshi (California Inst. of Tech., Pasadena). Jun 1970. Contract AT(11-1)-68. 12p. Dep. CFSTI.

Quark spin is incorporated into the Veneziano N-point function. Parity doubling and new ghosts are avoided by the introduction of fixed J-plane cuts. All resonances couple according to $U(6)_W \otimes O(2)_{L_z}$, and the model factorizes with essentially the same degeneracy as the usual Veneziano amplitude. As a consequence of the coupling symmetry, the amplitude's singularities at $s = \infty$ and $t = \infty$ are such that the amplitude has a finite "background" contribution. (auth)

37738 (COO-264-547) POMERANCHUK TERM IN THE DUAL QUARK MODEL. Freund, Peter G. O. (Chicago Univ., Ill.). May 1970. Contract AT(11-1)-264. 16p. (EFI-70-27). Dep. CFSTI.

The role of loop diagrams with an odd number of twisted vertices in ensuring the validity of Pomeranchuk's theorem is pointed out. A mechanism to boost the Pomeranchuk intercept to one is proposed. This mechanism relies upon the necessary existence of exotic hadrons in a dual theory. (auth)

37739 (RLO-1388-564) PERTURBATION THEORY AND SELF MASS INSERTIONS. Brown, Lowell S. (Washington Univ., Seattle. Dept. of Physics). [1969]. Contract AT(45-1)-1388. 22p. Dep. CFSTI.

First order perturbation corrections to strong interaction amplitudes are considered in the context of quantum field theory. It is shown that such corrections may be expressed entirely in terms of on-mass-shell matrix elements of the unperturbed system, matrix elements which are evaluated at the unperturbed mass. The general method is illustrated by a detailed discussion of form factor corrections. In particular, the method is applied to the conserved vector form factor of a meson multiplet, and it is shown that the Ademollo-Gatto theorem holds only if the perturbation is local. The violation of this theorem which occurs in the electromagnetic correction to pion β-decay is discussed. (auth)

37740 BOOTSTRAP MODEL FOR DIFFRACTIVE PROCESSES: COMPLEMENTARITY OF THE YANG AND REGGE MODELS. Hwa, Rudolph C. (State Univ. of New York, Strony Brook). Contract AT(30-1)-3668B. Phys. Rev., D; 1: 1790-1809(15 Mar 1970).

The Yang (or droplet) model and the Regge model for high-energy diffractive processes are contrasted, their complementarity emphasized. The combination of the physical aspect of the former with the mathematical aspect of the latter gives rise to a bootstrap model which has far-reaching consequences. The assumptions of the bootstrap model are: (a) High-energy inelastic processes are dominated by the two-cluster diffractive fragmentations; (b) the s dependences of diffractive scattering and fragmentation are the same; and (c) partial-wave amplitudes can be continued uniquely into the complex j plane. The bootstrap of the Pomeranchon in both the s and the t channel is studied using inelastic unitarity without approximation. The Pomeranchuk singularity is found to be a branch point with $\alpha(0) = 1$ exactly; discontinuity of the associated cut vanishes at the tip. Both forward and nonforward cases are considered. Various properties of diffractive scattering and fragmentation at high energy are obtained. On the basis of the bootstrap model, predictions are made on (1) the asymptotic behavior of σ_{tot}, (2) the ratio of real to imaginary parts of scattering amplitude, (3) the absence of physical manifestation of the Pomeranchon, (4) the dependence of fragmentation cross section on the effective masses of the particle clusters, (5) the average multiplicity of hadron production, (6) the diffraction peak of fragmentation process, and (7) the relationship between pp and γp diffraction peaks. All of these predictions are consistent with whatever relevant data are available at present. If, in addition, a technical assumption is made concerning the Reggeization of production amplitudes, the precise nature of the Pomeranchuk branch point can be determined. (auth)

37741 RELATIVISTIC QUARK MODEL BASED ON THE VENEZIANO REPRESENTATION. II, GENERAL TRAJECTORIES. Mandelstam, Stanley (Univ. of California, Berkeley). Phys. Rev., D; 1: 1734-44(15 Mar 1970).

The model previously proposed is extended to include multiquark trajectories. Once any trajectories with more than a single quark and antiquark are included, it is necessary to include trajectories where the number of quarks plus the number of antiquarks, which is called the total quark number, is arbitrarily large. The necessary factorization properties of the multiparticle Veneziano amplitudes will hold provided the intercept of the leading trajectory is a polynomial function of the total quark number, and the degeneracy of the levels on all but the leading trajectory will increase with the order of the polynomial. It is possible to

construct two different models depending on whether one allows nonplanar duality diagrams. The model with nonplanar diagrams resembles more closely the nonrelativistic harmonic-oscillator quark model, and the nonplanar duality diagrams must be associated with the nonplanar Veneziano amplitudes discussed in a previous paper. One can introduce SU(3) symmetry-breaking by making the intercept depend on the number of strange and nonstrange quarks separately, and one then obtains a modified Gell-Mann-Okubo mass formula. (auth)

37742 SUM RULES FROM SUGAWARA'S THEORY OF CURRENTS. Taha, M. O. (International Centre for Theoretical Physics, Trieste, Italy). Phys. Rev., D; 1: 1764-72(15 Mar 1970).

An integral representation is given for the matrix element, between single-particle states, of the product of currents at the same space-time point. It is applied to obtain sum rules from the equations of motion in Sugawara model. These sum rules, unlike the conventional Fubini-type sum rules, involve triple integrals over the absorptive parts of off-mass-shell current-hadron scattering amplitudes. Their physical content and utility require further investigation. (auth)

37743 SPINOR FORMALISM FOR DUAL-RESONANCE MODELS. Gordon, David; Ramond, P. (National Nuclear Accelerator Lab., Batavia, Ill.). Phys. Rev., D; 1: 1849-50 (15 Mar 1970).

A spinor formalism for the factorization of dual-resonance models is proposed. It is seen to lead to an SU(2) classification of the states. The symmetry of the propagator is discussed. (auth)

37744 PARTON VIEW OF DUAL AMPLITUDES. Nielsen, H. B. (NORDITA, Copenhagen); Olesen, P. Phys. Lett.; 32B: 203-6(22 Jun 1970).

Simple arguments based on a parton picture of hadrons are presented which show that the limit of sums of very high order, unrenormalized planar Feynman diagrams lead to dual N point functions. The parton mass turns out to be of the order of one GeV. (auth)

37745 GENERALIZATIONS OF W SPIN. Horn, D. (California Inst. of Tech., Pasadena); Ne'eman, Y. Contract AT(11-1)-68. Phys. Rev., D; 1: 2710-11(1 May 1970).

The generalization of W spin to orbital extensions of the quark model is discussed. The Lorentz-invariant properties and the predictive power of the assumptions are pointed out and a possible manifestation of the breaking of the rest (and collinear) symmetry. (auth)

37746 THEORY OF LARGE-MOMENTUM-TRANSFER HADRON PRODUCTION IN HIGH-ENERGY, INELASTIC HADRON-HADRON SCATTERING. Chen, Min-shih; Harte, John (Yale Univ., New Haven). Phys. Rev., D; 1: 2603-9(1 May 1970).

A model is developed to provide a framework for analyzing large-momentum-transfer hadron production in high-energy, inelastic hadron-hadron scattering. Two different production mechanisms, a peripheral and a central process, are found to play an important role in the high-energy wide-angle region. Each of these leads to a characteristic differential cross section for the process hadron + hadron → hadron + anything when the momentum transfer to the measured final-state hadron is large and varied. The production differential cross section dominated by a peripheral process is given by a product of an elastic amplitude and an inelastic structure function, while the one dominated by a central process is given by the product of two inelastic structure functions integrated over a restricted portion of phase space. The measured pion-production differential cross section in inelastic proton-proton scattering is found to be dominated by a peripheral process, while the proton production amplitude in inelastic pp scattering and the pion production amplitude in an as yet unexplored kinematical region are dominated by a central process. In addition, qualitative predictions for pion production in high-energy $p\bar{p}$ annihilation and pion, kaon, and proton production in inelastic πp and Kp scattering are made. (auth)

37747 BOOTSTRAP CONDITIONS FROM THE VENEZIANO REPRESENTATION. Capps, Richard H. (Purdue Univ., Lafayette, Ind.). Phys. Rev., D; 1: 2395-2402(15 Apr 1970).

A set of self-consistency conditions for ratios of hadron-hadron-hadron coupling constants is derived from the Veneziano model for scattering amplitudes and some simple assumptions. This set includes the crossing-matrix condition of the static meson-baryon model and the condition that the absence of resonances in exotic states implies a cancellation from Regge trajectories of opposite signatures. For simplicity, the spins of the external mesons and baryons are neglected. The conditions require that the particles correspond to representations of a Lie group, and that only certain sets of representations are allowed. The relation to previous bootstrap models is discussed. An illustrative solution corresponding to SU(3) is obtained. (auth)

37748 OPERATOR FORMULATION OF THE DROPLET MODEL. Lee, Benjamin W. (State Univ. of New York, Stony Brook). Contract AT(30-1)-3668B. Phys. Rev., D; 1: 2361-9(15 Apr 1970).

The implications of the operator formulation of the droplet model are studied in detail. The picture of high-energy scattering that emerges from this model attributes the interaction between two colliding particles at high energies to an instantaneous, multiple exchange between two extended charge distributions. Thus the study of charge correlation functions becomes the most important problem in the droplet model. It is found that in order for the elastic cross section to have a finite limit at infinite energy, the charge must be a conserved one. In quantum electrodynamics the charge in question is the electric charge. In hadronic physics it is conjectured, it is the baryonic charge. Various arguments for and implications of this hypothesis are presented. Formal properties of the charge correlation functions that follow from microcausality, T, C, P invariances, and charge conservation are studied. Perturbation expansion of the correlation functions is studied, and their cluster properties are deduced. A cluster expansion of the high-energy T matrix is developed, and the exponentiation of the interaction potential in this scheme is noted. The operator droplet model is put to the test of reproducing the high-energy limit of elastic scattering in quantum electrodynamics found by Cheng and Wu in perturbation theory. It is found that the droplet model reproduces exactly the results of Cheng and Wu as to the impact factor. In fact, the "impact picture" of Cheng and Wu is completely equivalent to the droplet model in the operator version. An appraisal is made of the possible limitation of the model. (auth)

37749 BJORKEN LIMIT IN PERTURBATION THEORY. Adler, Stephen L.; Tung, Wu-ki (Inst. for Advanced Study, Princeton, N. J.). Phys. Rev., D; 1: 2846-59(15 May 1970).

Detailed calculations illustrating the breakdown of the Bjorken limit in perturbation theory are presented in the "gluon" model of strong interactions. To second order in the gluon-fermion coupling constant in the scalar, pseudoscalar, and vector coupling models, the Bjorken-limit commutator of a pair of currents of arbitrary (vector, axial-vector, scalar, pseudoscalar, tensor) type is calculated. To fourth order in the coupling, in the scalar- and pseudoscalar-gluon models, the leading logarithmic behavior of the SU_3-antisymmetric part of the vector-vector commutator is determined. The main results are presented and their various features and implications are discussed. The computational details are relegated to two appendices. (auth)

37750 SUBSIDIARY CONDITIONS AND GHOSTS IN DUAL-RESONANCE MODELS. Virasoro, M. A. (Univ. of Wisconsin, Madison). Contract AT(11-1)-888. Phys. Rev., D; 1: 2933-6 (15 May 1970).

The possible subsidiary conditions compatible with the equations of motion of dual resonance models are investigated for the unrealistic choice of $\alpha(0) = 1$. In the language of four-dimensional harmonic oscillators, one subsidiary condition is found for each mode of oscillation. All time components (in the c.m. system) can therefore be eliminated. The possibility of relaxing the condition $\alpha(0) = 1$ is discussed. (auth)

37751 MASS DEPENDENCE IN THE DIRAC QUARK MODEL. Rosen, Gerald (Drexel Inst. of Tech., Philadelphia). Phys. Rev., D; 1: 2880-1(15 May 1970).

The dependence of an eigenvalue hadron mass m on a constituent quark or antiquark mass $M_{(s)}$ must be such that $|\partial m/\partial M_{(s)}| < 1$ if the dynamics of a system composed of n′ quarks and $(n - n')$ antiquarks is described by an n-particle Dirac Hamiltonian. By evoking the quasi-independent quark-model approximation, $\partial m_N/\partial M \propto 2.378$ is obtained for the rate at which the nucleon mass would change theoretically subject to a simultaneous increase in the three constituent strangeness-zero quark masses M. In the case of a potential with Coulomb-Schwinger homogeneity under scale transformations, a linear mass relation is found without appeal to the quasi-independent quark-model approximation. The latter mass relation yields correct mass values for the parallel-spin hadrons with $L = 0$ (the $J^P = 1^-$ mesons and $J^P = \frac{1}{2}^+$ baryons) and exhibits consistency in the $|S| = 1$ quark-antiquark mass M′ to $S = 0$ quark-antiquark mass M ratio: $M'/M = 1.345 \pm (0.005)$. (auth)

Strong (Baryon No. = 0)

Refer also to abstracts 37661, 37746, 37852, 37884, 37953, 37954, and 37969.

37752 (CALT-68-262) REVIEW OF EXOTIC MESONS. Rosner, Jonathan L. (California Inst. of Tech., Pasadena.

Minnesota Univ., Minneapolis). [1970]. Contract AT(11-1)-68. 35p. (CONF-700525-2). Dep. CFSTI.

From Experimental Meson Spectroscopy Conference, Philadelphia, Pa.

The review of exotic mesons covers some theories of exotic mesons, exotic exchanges, spectroscopic evidence for type-I exotics, and the evidence for type-II and -III exotics. No conclusive evidence is found for the existence of exotic mesons. (J.F.P.)

37753 (LNF-69/71) A MODEL FOR THE POMERANCHUK TERMS. Note No. 458. Greco, M. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). 26 Nov 1969. 9p. Dep. CFSTI (U. S. Sales Only).

A model for all the Pomeranchuk terms is constructed by taking into account some general properties associated to the leading vacuum singularity. It gives a very good description of the $p\bar{p}$, pp total and differential cross sections, and provides an accurate determination of the Pomeranchuk parameters. (auth)

37754 (SLAC-PUB-776) RESONANCE MIXING, "DIPOLES" AND "ZOMBIES". Stodolsky, Leo (Stanford Linear Accelerator Center, Calif.). Jun 1970. 14p. (CONF-700525-3). Dep. CFSTI.

From Experimental Meson Spectroscopy Conference, Philadelphia, Pa.

A simple formalism for treating the problems of resonance mixtures is reviewed. The mass matrix formalism, resonance production, nonorthogonality, and the dipole are covered. (J.F.P.)

37755 HELICITY AMPLITUDES IN THE FACTORIZATION QUARK MODEL FOR BARYON–BARYON SCATTERING. I. $pp \rightarrow pp$ SCATTERING. Weiner, Richard M. (Univ. of Bucharest). Rev. Roum. Phys.; 14: 1045-61(1969).

Two-body baryon–baryon scattering amplitudes are expressed in terms of quark amplitudes, taking into account spin in the helicity formalism. Quarks are assumed to interact in the spirit of the factorization quark model developed previously. SU(6) symmetry is used to express the particle wave functions in terms of quarks. By assuming that the three quarks of a baryon with momentum p have practically the same momentum p/3, there are 16 distinct 3-quark amplitudes for each of the five independent helicity amplitudes, which are computed for the process $P\bar{P} \rightarrow P\bar{P}$. (auth)

37756 BOSON MASSES. III. Peaslee, D. C. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Phys. Rev., D; 1: 1663-6(15 Mar 1970).

Empirical boson assignments on the baryon–antibaryon model are used to analyze exhaustively the masses for 13 out of 16 expected P orbitals; on this basis search areas can be predicted for the missing three states, all having $I = 0$ and $J^P = 1^+$. The mass analysis alone does not necessarily require much SU_3 singlet-octet mixing. Extrapolation to D states appears to pose a contradiction between this model and exchange degeneracy of normal boson trajectories. The situation can be resolved empirically by determining accurate J^P values for the prominent $I = 1$ bosons in the R–S region of missing-mass spectrometer assignments. Tentative evidence for a first radially excited octet with $J^P = 0^-$ places it in a mass region consonant with the model. (auth)

37757 OCTET ENHANCEMENT IN A MODEL OF VECTOR MESONS. Chan, Choi-lai (Univ. of Hong Kong). Phys. Rev., D; 1: 1810-12(15 Mar 1970).

A simple bootstrap model of vector mesons is constructed in which the origin of octet enhancement is examined. A parametrized-one-pole approximation is used to solve the N/D equations The pole parameter is determined by the bootstrap condition and the type of asymmetric solution that emerges. It is demonstrated that the emergence of the Gell–Mann–Okubo formula follows from two general dynamical requirements: the bootstrap self-consistency condition and the requirement that the "vector mesons" are real physical particles and not ghost states. (auth)

37758 VENEZIANO AMPLITUDE, CURRENT ALGEBRA, AND VERTEX FUNCTIONS. Arnowitt, R.; Friedman, M. H.; Nath, P. (Northeastern Univ., Boston). Phys. Rev., D; 1: 1813-20(15 Mar 1970).

The possibility is examined of extending the $\pi\pi \rightarrow \pi\pi$ and $\pi A_1 \rightarrow \pi\pi$ Veneziano amplitudes to the case of one or two mesons off the mass shell in a fashion consistent with chiral current algebra, partial conservation of axial-vector current, and conserved vector current. Soft-pion formulas for the pion-vector form factor and the σ-commutator vertex are deduced. The hard-meson analysis shows that if one wishes to maintain Veneziano form with two mesons off the mass shell, some of the $\pi A_1 \rightarrow \pi\pi$ amplitudes must develop poles in one of the off-shell momenta at $p^2 = 0$. The soft-pion vertex function equations are seen to be a consequence of removing the leading part of this singularity at the soft-pion point $p^\mu = 0$. However, the resultant amplitudes are still singular at $p^2 = 0$, $p^\mu \neq 0$ for a continuum of s, t, and u. The fixed poles implied by the presence of form factors (when two mesons are off shell) are seen to occur only in those amplitudes orthogonal to the A_1 polarization vector and do not affect the amplitudes that make nonzero contributions for $\pi A_1 \rightarrow \pi\pi$ scattering on the mass shell. (auth)

37759 PROPERTIES OF THE VENEZIANO FIVE-POINT FUNCTION IN THE REGGE REGION. Jones, Lorella; Wyld, H. W. Jr. (Univ. of Illinois, Urbana). Contract NSF GP 9273. Phys. Rev., D; 1: 1840-2(15 Mar 1970).

Differential cross sections for the quasi-two-body meson process $\sigma\sigma \rightarrow (\sigma\sigma)\sigma$ (where σ is a scalar, isoscalar pion) are calculated using the Bardakci–Ruegg formula for $\sigma\sigma \rightarrow \sigma\sigma\sigma$. The slope of $d\sigma/dt$ in the $2 \rightarrow 2$ reaction is found to change with the $(\sigma\sigma)$ mass in a manner similar to experiment. The shape of predicted resonances in the $(\sigma\sigma)$ mass is, however, distinctly different from the Breit–Wigner form. (auth)

37760 ANALYTIC HARD-PION CALCULATION OF THE $T = J = 0$ $\pi\pi$ PHASE SHIFT. Brehm, J. J.; Golowich, E.; Prasad, S. C. (Univ. of Massachusetts, Amherst). Phys. Rev. Lett., 25: 67-70(6 Jul 1970).

Using chiral SU(2) current algebra, a dynamical equation is derived for the form factor which describes the sigma-field matrix element between single-pion states. With the aid of the model of Gell–Mann, Oakes, and Renner, this equation is solved in an effective-range approximation, and from unitarity the $T = J = 0$ $\pi\pi$ phase shift is deduced. The analysis strongly favors the "up-down" set of phenomenological $\pi\pi$ phase shifts, and rules out a narrow ϵ resonance. (auth)

37761 RISING PHASE-SHIFT MODEL AND EVIDENCE FOR DAUGHTERS IN THE REACTION $\bar{p}n \rightarrow \pi^-\pi^+\pi^-$. Gleeson, Austin M. (Univ. of Texas, Austin); Meggs, William J.; Parkinson, Michael. Phys. Rev. Lett.; 25: 74-8(6 Jul 1970).

It is shown that many of the features of the recent data on the reaction $\bar{p}n \rightarrow \pi^-\pi^+\pi^-$ may be explained without recourse to a Veneziano model. A direct fit of particle parameters is obtained by parametrizing the amplitude in terms of the resonance poles in the two nonexotic channels. The existence of daughters is found to be crucial to the fit to the data. No evidence is seen of higher spin resonances; and in all cases, the daughter mass is not degenerate with the parent mass. (auth)

37762 CURRENT ALGEBRAS AND MESON DECAYS. Nagy, Tibor (Princeton Univ., N. J.). Phys. Rev., D; 1: 2119-26 (1 Apr 1970).

By using quark-algebra equal-time commutation relations and a smooth pole-dominated form for the vector–vector–axial-vector vertex in the high-energy limit, the radiative decays of the vector mesons and the $\omega \rightarrow 3\pi$ decay can be described in excellent agreement with experimental data. It is shown, however, that if all equations are exploited, this procedure leads to contradictions By introducing a non-smooth amplitude, the contradictions can be eliminated in such a way that the good predictions of the smooth case remain unaltered. The various aspects of the results are discussed. (auth)

37763 PRODUCTION DEPENDENCE OF THE $A_2(1300)$ MASS DISTRIBUTION. Coleman, T. P. (Ames Lab., Iowa); Lassila, K. E. Phys. Rev., D; 1: 2192-5(1 Apr 1970).

It is demonstrated that much of the variation in mass shape and position of the $A_2(1300)$ meson from experiment to experiment is consistent with a model of two coupled or interfering wide- and narrow-width particles which may be close to forming a double-pole system. It is found that the double-pole limit of this model leads to reasonably good fits for the mass spectra of the $\pi\rho$ and $K\bar{K}$ decay channels produced in π^-p and $\bar{p}p$ collisions. Also, the model is consistent within experimental resolution with the available $\pi\rho$-decay-channel mass spectra found in the reaction $K^-n \rightarrow A_2^-A$. Predictions for other reactions involving A_2 production are made. (auth)

37764 GOLDHABER DISTRIBUTIONS FOR FOUR-PION DECAYS OF ISOSINGLET BOSONS. Weller, G. V. (Univ. of Wisconsin, Madison); Dotson, A. C. Phys. Rev., D; 1: 2169-79 (1 Apr 1970).

In order to estimate the usefulness of Goldhaber-distribution analysis as a spin-parity text for four-pion resonances, the distributions for two spin-parity choices in each of two symmetry types are compared. The significance of two plotting schemes is investigated and the dependence of the results on the algebraic form assumed for the matrix element is estimated. Both plotting schemes are found to be useful and three of the four distribution types are relatively form-independent. (auth)

37765 CURRENT-ALGEBRA PREDICTIONS OF $\omega-\varphi$ MIXING. Wienke, B. R.; Deshpande, N. G. (Northwestern Univ., Evanston, Ill.). Phys. Rev., D; 1: 2180-1(1 Apr 1970).

Weinberg's first sum rule is coupled to a general isospin-conserving symmetry-breaking interaction to predict the $\omega-\varphi$ mixing angle along with associated vector-meson mass sum rules which are listed for comparison with experiment. Both $(\text{mass})^2$ and $(\text{mass})^{-2}$ sum rules are considered. (auth)

37766 ANALYTICITY, UNITARITY, AND NONRESONANT BACKGROUND SCATTERING. Johnson, R. C. (Durham Univ., Eng.). Phys. Lett.; 32B: 199-202(22 Jun 1970).

Requiring simultaneously analyticity and unitarity of an amplitude with an isolated elastic resonance at low energy leads to predictions of the sign and magnitude of associated non-resonant background phase shifts. The case of isospin-2 $\pi-\pi$ scattering in the ρ-meson energy region is considered in detail, and results include a useful bound on the two S-wave $\pi-\pi$ scattering lengths. It is pointed out that analogous reasoning may be applied to isospin $-\frac{3}{2}$ $\pi-K$ scattering near the K*(890). (auth)

37767 CONSTRUCTION OF PHYSICAL DUAL-RESONANCE MODELS. Rittenberg, V.; Rubinstein, H. R. (Weizmann Inst. of Science, Rehovot, Israel). Phys. Rev. Lett.; 25: 191-4(20 Jul 1970).

Six- and eight-charged-pion amplitudes are constructed and studied. Factorization properties of the parent π trajectory show the π and A_1 to be simple and the $\pi(2^-)$ to be a double state reminiscent of the A_2 doubling. (auth)

37768 ALGEBRAIC ASPECTS OF PIONIC DUALITY DIAGRAMS. Susskind, Leonard; Frye, Graham (Yeshiva Univ., New York). Phys. Rev., D: 1: 1682-6(15 Mar 1970).

Certain algebraic aspects are abstracted from the duality principle and are incorporated in a simple model of pion n-point functions. An algorithm for constructing the n-point function in the tree-graph approximation is based on the duality assumption and the Adler condition which states that the amplitudes vanish if any pion four-momentum vanishes, all others remaining on shell. The resulting amplitudes satisfy the constraints of current algebra and partial conservation of axial-vector current for n = 4, 6, and 8, and (we conjecture) for all n. In addition, duality specifies a definite form for chiral symmetry breaking. (auth)

37769 SPONTANEOUS $\phi-\omega$ MIXING IN A VECTOR NONET MODEL. Chan, Choi-lai (Univ. of Hong Kong). Phys. Rev., D; 1: 2421-5(15 Apr 1970).

A previous model of vector mesons is extended to study $\phi-\omega$ mixing in a vector nonet. It is found that a phenomenon which can be interpreted as "spontaneous mixing" does occur in the model, and the well-known equations $\phi^2+\omega^2=2K^{*2}$ and $4K^{*2}-3(\cos^2\theta\phi^2+\sin^2\theta\,\omega^2)-\rho^2=0$ emerge from the calculation. The mixing angle cannot be determined in our model; but it is found that if violations to SU(3) become vanishingly small, a 50% mixing occurs. (auth)

37770 SATELLITE TERMS IN VENEZIANO MODELS. Kreps, R. E.; Milgram, M. S. (Univ. of Toronto). Phys. Rev., D; 1: 2271-7(15 Apr 1970).

It is shown that many of the satellite terms possible in Veneziano models are linearly dependent, and that, in fact, specification of the residues of the poles is arbitrary, but completely determines all the coefficients of the satellite terms. Implications of this for ghosts, parity doubling, daughters, asymptotic behavior, Adler zero, and finite-energy sum rules are discussed. A specific numerical example for $\pi-\pi$ scattering is given. (auth)

37771 PHASE CONTOURS IN $\pi\pi$ SCATTERING. Soffer, Jacques (Centre National de la Recherche Scientifique, Marseille). Phys. Rev., D; 1: 2309-15(15 Apr 1970).

The phase-contour method is applied to the study of $\pi\pi$ scattering. The effect of the $\sigma(0^+)$ resonance, for which there is now very good experimental evidence is included, and its relation with the Adler zero is discussed. A general description of the phase contours is obtained for several isospin amplitudes having different types of symmetry, in particular, mixed symmetry and exchange-degenerate trajectories in one channel. (auth)

37772 CHIRAL SU(3) ⊗ SU(3) MASS SPECTRA AND THE GENERALIZED "$\omega\rho\pi$" INTERACTION. Brown, Laurie M. (Northwestern Univ., Evanston, Ill.); Munczek, Herman. Phys. Rev., D; 1: 2595-2602(1 May 1970).

The interaction between a pseudoscalar and two vector mesons is discussed within the context of chiral SU(3) ⊗ SU(3) symmetry. Assuming that the interaction transforms like a combination of zeroth and eighth components of a (3,3*) ⊕ (3*,3) representation, in a phenomenological Lagrangian treatment, previous SU(3) parametrization of the related meson decay rates can be reproduced. In addition interaction terms are obtained for the decays of the X^0 meson. Also the mass spectrum of the vector, axial-vector, and pseudoscalar mesons are studied when these last belong to a nonlinear representation and when they are part of a linear representation which includes scalar mesons. In the latter case it is found that the κ-K* mixing is negligible. (auth)

37773 DUAL AMPLITUDES WITH ω-COUPLING FOR SIX PIONS AND FOR SPINNING BOSONS. Gabarro, J.; Mestres, L. Gonzalez (Faculte des Sciences, Orsay, France). Lett. Nuovo Cim.; 4: 86-92(11 Jul 1970).

Veneziano-type formulas are constructed for processes involving six pseudoscalar bosons. Four-point formulas involving spinning bosons are also constructed. (L.B.S.)

37774 UNITARY AND CROSSING-SYMMETRIC $\pi-\pi$ S-WAVES. Gensini, P.; Soliani (Univ., Lecce, Italy. Istituto Nazionale di Fisica Nucleare, Bari, Italy). Nuovo. Cim.; 68A: 293-300(21 Jul 1970).

Crossing-symmetry constraints on $\pi-\pi$ partial waves derived by Roskies are applied to unitarized version of the Veneziano model proposed by Lovelace: the results so found for S-waves are in good agreement with both current-algebra models and experimental information. (auth)

37775 RIGOROUS INEQUALITIES ON THE DERIVATIVES OF S- AND P-WAVE AMPLITUDES FOR $\pi-\pi$ SCATTERING. Auberson, G. (Centre d'Etudes Nucleaires de Saclay, Gif-sur-Yvette, France). Nuovo Cim.; 68A: 281-92(21 Jul 1970).

Inequalities involving the S- and P-wave pion-pion amplitudes and their first derivatives are obtained from crossing symmetry and positivity properties for some isospin combinations. They can be used to test low-energy models. (auth)

37776 ADLER CONDITION FOR η MESONS AND (3,3*) + (3*,3) SYMMETRY BREAKING IN A CHIRAL SU(3) ⊗ SU(3) LAGRANGIAN MODEL. Turner, Leaf (Univ. of Toronto). Phys. Rev., D; 1: 3466-7(15 Jun 1970).

A chiral SU(3) ⊗ SU(3) Lagrangian model with Gell-Mann–Oakes–Renner symmetry breaking is derived explicitly in terms of the pseudoscalar SU(3) octet fields, ϕ_i. It is shown that the imposition of the Adler consistency condition on η mesons implies $\eta=\phi_8+c(\mu_{K^2}-\mu_{\pi^2})v_0$. Hence, only if η is assumed to transform as ϕ_8 does the difficulty of the Veneziano model $\mu_{K^2}=\mu_{\pi^2}=\mu_{\eta^2}$ exist. (auth)

37777 MULTIPERIPHERAL MECHANISM FOR A SCHIZOPHRENIC POMERANCHON. Chew, Geoffrey F.; Snider, Dale R. (Univ. of California, Berkeley). Phys. Rev., D; 1: 3453-8(15 Jun 1970).

It is demonstrated through an explicit model that the weak high-subenergy tail of the multiperipheral kernel, acting in conjunction with the strong low-subenergy component, is capable of producing a high-ranking output Regge doublet with vacuum quantum numbers. It is shown that association of the upper doublet member with the P (Pomeranchon) and the lower with the P′ is consistent with experimental total, elastic, and diffractive dissociation cross sections, as well as with multiplicity of produced pions, and predicts a Pomeranchon slope near t = 0 that is roughly half normal. As t becomes negative, the Pomeranchon slope decreases to a small value, while for t positive the slope increases to a normal value, the P trajectory containing the particles usually assigned to the P′. The latter trajectory has a converse behavior, with small slope for positive t and normal slope at negative t. The P and P′ trajectories thus exchange "normal" and "abnormal" roles near t = 0. (auth)

Strong (Baryon No. = 1)

Refer also to abstracts 37407, 37659, 37746, 37891, and 37953.

37778 (COO-1428-214) $\eta-\eta'$ MIXING ANGLE OF −24° FROM A REGGE-MODEL FIT TO CROSS SECTIONS. Miller, W. J.; Gaidos, J. A.; Loeffler, F. J. (Purdue Univ., Lafayette, Ind.); Campbell, J. H. (Argonne National Lab., Ill.). [1970]. 7p. (CONF-700806-7). Dep. CFSTI.

From 15th International Conference on High Energy Physics, Kiev, USSR.

Application of a Regge model used for $\pi N\to N\eta$ to recent $\pi n\to p\eta'$ data gives a ratio of coupling constants for the two reactions. From this ratio an $\eta-\eta'$ mixing angle of $-24°\pm3°$ is obtained in agreement with the linear mass formula. (auth)

37779 (COO-1428-219) ON THE NEUTRAL DIPION MASS DISTRIBUTIONS IN THE REACTIONS $\pi^+n\to p\pi^+\pi^-$ AND $\pi^-p\to\Delta^{++}\pi^+\pi^-$ AT 13 GeV/c. Paler, K.; Badewitz, R. C.; Barton, H. R. Jr.; Miller, D. H.; Palfrey, T. R. Jr.; Tebes, J. (Purdue Univ., Lafayette, Ind.). [1970]. 10p. (CONF-700806-11). Dep.

CFSTI. From 15th International Conference on High Energy Physics, Kiev, USSR.

A study of the neutral dipion effective mass distributions produced in the reactions a) $\pi^+n \rightarrow p\pi^+\pi^-$ and b) $\pi^+p \rightarrow \Delta^{++}\pi^+\pi^-$ is presented. By dividing the dipion distributions in reactions a) and b) by the dipion background distributions obtained from the reactions $\pi^+p \rightarrow n\pi^+\pi^+$ and $\pi^-p \rightarrow \Delta^{++}\pi^-\pi^-$ respectively similar dipion distributions are obtained. These distributions are qualitatively described by a Veneziano amplitude. (auth)

37780 (NP-tr-1904) THE SIMULATION OF PERIPHERAL INTERACTIONS. [PART] I. Kopylov, G. I. (Joint Inst. for Nuclear Research, Dubna (USSR)). Translated by J. B. Sykes (Atomic Energy Research Establishment, Harwell, Eng.), from report JINR-P1-4290, 10p, Dep. CFSTI (U. S. Sales Only). Handwritten MS. copy.

This item was previously abstracted from the original language and appeared in NSA as 23: 23393.

37781 RELATIVISTIC QUARK MODEL BASED ON THE VENEZIANO REPRESENTATION. III. BARYON TRAJECTORIES. Mandelstam, Stanley (Univ. of California, Berkeley). Phys. Rev., D; 1: 1745-53(15 Mar 1970).

Results previously obtained for the meson trajectories in the Veneziano quark model are here derived for the baryon trajectories. The SU(0) spectrum of particles and the SU(0,0) spectrum of trajectories are analyzed. Vertex functions for three physical particles or for two physical particles and one Reggeon are calculated. Two mixing parameters can be adjusted so that the ratios between the couping constants will be those predicted by $SU(0)_W$. The model is applied to determine quantitatively the value of the ρ residue used in Regge fits or pion-nucleon scattering. (auth)

37782 PREDICTION OF A METASTABLE Y_0^* BARYON. Rosen, G. (Drexel Inst. of Tech., Philadelphia). Can. J. Phys.; 47: 238-40(15 Jan 1969).

On the basis of an empirical mass formula for the baryon octuplet and baryon resonance decuplet, the existence of a metastable $J^P = 1/2^+$ unitary singlet baryon state with a mass greater than about 2500 MeV is conjectured. Predominantly the I = Y = 0 octuplet member but with a small admixture of the unitary singlet, the Λ baryon would appear as a superposition of the unitary states. The complementary baryon, a metastable $J^P = 1/2^+$ Y_0^* composed mainly of the unitary singlet, is predicted. (auth)

37783 EXCHANGE DEGENERACY FOR BARYON TRAJECTORIES. Chavda, L. K.; Capps, R. H. (Purdue Univ., Lafayette, Ind.). Phys. Rev., D; 1: 1845-6(15 Mar 1970).

Consistency conditions on the coupling of baryonic Regge trajectories to meson-baryon states are exhibited, and solutions are found. The set of conditions is an extension of sets derived in previous references from a duality assumption. (auth)

37784 TEST OF VENEZIANO MODEL USING ρ-MESON SPIN-DENSITY MATRIX ELEMENTS. Morrow, Richard A. (Dartmouth Coll., Hanover, N. H.). Phys. Rev., D; 1: 2113-15 (1 Apr 1970).

It is shown in conventional Regge theory that the spin-density matrix elements of ρ mesons produced by scattering pions off nucleons have the properties that $(\rho_{11}-\rho_{1,-1})/\rho_{00}$ and $2(|\rho_{10}|/\rho_{00})^2$ are equal and dependent only on pion exchange at very high energies. The ratio $\rho_{10}/\rho_{00} \approx (\mathrm{Re}\rho_{10})/\rho_{00}$ in a generalized Veneziano model is then found to agree with data at 8-GeV/c pion laboratory momentum. (auth)

37785 INTERFERENCE MODELS, UNITARITY, AND DUALITY IN FORWARD PION-NUCLEON SCATTERING. Ciftan, Mikael; Patsakos, George (Indiana Univ., Bloomington). Phys. Rev., D; 1: 2156-68(1 Apr 1970).

Four interference models which can be constructed from Regge, resonance, and absorptive basic amplitudes were analyzed. The models result from the hypothesis that the S matrix factors into components which describe the contributions of various mechanisms (Regge, resonance, absorption) to the scattering. Additional terms, which involve integrals over products of the basic amplitudes, are thereby introduced naturally into the T matrix for each model. This formalism takes account, at least in part, of the requirements of unitarity. Although the additional terms so introduced into the total amplitude eliminate much of the double counting present in, for example, the usual Regge-resonance model, the particular model constructed from resonance and absorption amplitudes gives the best agreement with experiments for $s \lesssim 5$ GeV^2 even without any attempt at fitting. This model is then extended to higher energies by introducing Regge trajectories to support the recurrences of the low-lying N and Δ resonances. After fixing the parameters of the trajectories by fitting the data up to s = 10 GeV^2, a good representation of the experimental data up to $s \approx 25$ GeV^2 is obtained. The results lend additional support to the idea of duality, and suggest that several not well-established, as well as many new, resonances are needed to fit the data and do not require an isotopic spin-dependent absorptive amplitude. (auth)

37786 FINAL-STATE INTERACTION ANALYSIS FOR THE REACTION $\pi^- + p \rightarrow \pi^- + K^0 + \Sigma^+$. Chiang, Heng C. (Carnegie-Mellon Univ., Pittsburgh). Phys. Rev., D; 1: 2096-2108(1 Apr 1970).

The final-state interaction effects in the reaction $\pi^- + p \rightarrow \pi^- + K^0 + \Sigma^+$ are analyzed in a perturbation model. It is shown that with a reasonably assumed π-K interaction strength, some effects in the Dalitz plot can be produced. The π-K rescattering effects on the polarization of the Σ are examined. It is concluded that even if the rescattering effects are important, a determination of the parity of the $Y_0^*(1405)$ by measuring the polarization of the Σ is still plausible. (auth)

37787 ANALYSIS OF LOW-ENERGY K^+p SCATTERING DATA BY A NEW METHOD. Cutkosky, R. E.; Deo, B. B. (Carnegie-Mellon Univ., Pittsburgh). Phys. Rev., D; 1: 2547-57(1 May 1970).

A new method, recently devised by us, is used for the analysis of K^+p scattering data below 1.5 GeV/c. This analysis uses, instead of the ordinary partial-wave expansion, a method of expansion with optimally accelerated convergence properties; the metho. has been devised by the use of analytic approximation theory. Although no experimental information is used which was not available to Lea, Martin, and Oades, somewhat more definite results are obtained by the present method. The results are sensitive to the values assumed for the coupling constants g^2_{NA} and g^2_{NE}; the results appear to be most consistent if values close to the SU_3 prediction are used for these coupling constants. With the use of the SU_3 prediction, rather strong P-wave scattering is found in the low-energy region. (auth)

37788 FORWARD PEAK STRUCTURE IN QUASI-TWO-BODY REACTIONS AND LONG-RANGE PION EXCHANGE. Stevens, Paul R. (Univ. of California, Los Angeles). Phys. Rev., D; 1: 2523-37(1 May 1970).

It is found that a coherent-droplet model with long-range pion exchange successfully fits the forward peak structure of the differential cross sections for $\pi^+p \rightarrow \rho^0\Delta^{++}$, $\pi^+p \rightarrow f^0\Delta^{++}$, $\pi^-p \rightarrow \rho^0n$, $\pi^+p \rightarrow \rho^+p$, $pp \rightarrow n\Delta^{++}$, $K^-p \rightarrow K^{*0}(890)n$, and $K^-p \rightarrow K^{*-}(890)p$. For $-t' \lesssim 0.02$ (GeV/c)^2, the measured differential cross sections exhibit anomalous behaviors: spikes and dips and no structure. The different behaviors are explained mainly by the kinematic structure of pion-pole residues. In some of the reactions, the known magnitude of the pion-pole residue leads us to expect structures near t' = 0 which require data with higher statistical precision for confirmation. In $\pi^+p \rightarrow f^0\Delta^{++}$ at 8 GeV/c, the model can explain the absence of an anomaly near t' = 0 in terms of the large distance from the physical region to the pion pole. However, this distance decreases with increasing energy, and our model predicts structure near t' = 0 in $\pi^+p \rightarrow f^0\Delta^{++}$ at 16 GeV/c. (auth)

37789 $\pi\rho$ MASS ENHANCEMENT FOR THE BACKWARD REACTION $\pi^-p \rightarrow p(\pi\rho)^-$ IN A DOUBLE-REGGE-POLE MODEL. Shih, Chia-chang; Young, Bing-lin (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., D; 1: 2631-7(1 May 1970).

Using a double-Regge-pole model, the $\pi\rho$ mass enhancement in the backward reaction $\pi^-p \rightarrow p(\pi\rho)^-$ is investigated. Broad peaks occur in this model near the A_1 mass. They are found to persist under a wide range of Regge-parameter values. Similar features also hold for the forward reaction cases. It is concluded that the mass enhancement comes from the interplay of the phase-phase kinematics and the peripheral nature of the Regge amplitude; the specific intercept and slope values of the trajectories are not very crucial. On the basis of these findings, the implications of the duality principle, isospin complications, and the practical problem of how to describe the A_1 are discussed. (auth)

37790 ARGAND DIAGRAMS,CROSS-SECTION BEHAVIOR, AND REGGE POLES. Masuda, Naohiko (Louisiana State Univ., Baton Rouge). Phys. Rev., D; 1: 2565-77(1 May 1970).

Schmid's problem on the interpretation of the anticlockwise Argand diagram obtained from Regge-pole exchanges as the direct-channel resonance is studied. It is shown in the idealized models that the anticlockwise Argand diagram alone cannot guarantee the existence of a resonance, and that is is absolutely necessary to compute the cross section in order to establish the existence of a resonance. The partial-wave projection of the Regge-pole exchanges in pion-nucleon scattering is performed. The Argand diagram, real part of phase shift, absorption factor, partial-wave total cross section σ^{tot}, elastic cross section σ^{el}, $k^2\sigma^{tot}$, and $k^2\sigma^{el}$

are computed. It is found that all σ^{tot} and σ^{el} have no cross-section peak at all, despite the existence of the anticlockwise Argand loops in certain partial waves. They show only the monotonically decreasing behavior characteristic of the Regge-pole model as energy increases, except in the unitarity-violating low-energy region. The above facts indicate that the variation of the anticlockwise Argand loop with respect to energy is too weak to produce a cross-section peak by overcoming the variation of the barrier factor $1/k^2$ in σ^{tot} and σ^{el}. It is concluded that Schmid's interpretation is incorrect. Several physical implications of this result are discussed. (auth)

37791 REAL PARTS OF MESON–NUCLEON FORWARD SCATTERING AMPLITUDES. Horn, D.; Yahil, A. (California Inst. of Tech., Pasadena). Contract AT(11-1)-68. Phys. Rev., D; 1: 2610-14(1 May 1970).

A dispersion-relation calculation of the real parts of forward $\pi^{\pm}p$ and $K^{\pm}p$ scattering amplitudes is carried out under the assumption of constant total cross sections in the Serpukhov energy range. Comparison with existing experimental results as well as predictions for future high-energy experiments is presented and discussed. Electromagnetic effects are found to be too small to account for the expected difference between the π^-p and π^+p total cross sections at higher energies. (auth)

37792 BARYON TRAJECTORIES WITHOUT MACDOWELL PARTNERS. Ball, J. S. (Univ. of Utah, Salt Lake City); Kaus, Peter. Contract AT(11-1)-34. Phys. Rev., D; 1: 2712-13(1 May 1970).

It is shown that baryon trajectories can be constructed which are in agreement with the observed π–N resonance spectrum as well as backward scattering data and yet have no MacDowell partners. This is accomplished by including appropriate physical branch points in the trajectory function. (auth)

37793 REGGEON COUPLINGS TO BARYONS. Rosner, Jonathan L. (California Inst. of Tech., Pasadena). Contract AT(11-1)-68. Phys. Rev., D; 1: 2701-2(1 May 1970).

A recently developed description of Reggeon couplings to baryons in terms of s-channel baryonic resonances is extended to more general f/d ratios for meson-baryon-resonance couplings, including those values of f/d appearing in SU(6). (auth)

37794 MULTIPLE-SCATTERING QUARK MODEL AND THE SERPUKHOV πN TOTAL CROSS SECTIONS. Dean, Nathan W. (Vanderbilt Univ., Nashville). Phys. Rev., D; 1: 2703-5(1 May 1970).

It is shown that the Serpukhov data on πN total cross sections between 30 and 65 GeV/c are in excellent quantitative agreement with the fits obtained earlier using a Reggeized quark model with multiple scattering. The predictions of the model for pion-nucleon differential cross sections and polarizations in this energy range are given. (auth)

37795 EXAMINATION OF ρ^0 DENSITY MATRIX ELEMENTS USED FOR VECTOR-DOMINANCE-MODEL TESTS. Biswas, N. N.; Cason, N. M.; Johnson, P. B.; Kenney, V. P.; Poirier, J. A.; Shephard, W. D. (Univ. of Notre Dame, Ind.). Phys. Rev., D; 1: 2705-7(1 May 1970).

The data on ρ^0 production in π^-p interactions which have been used in tests of the vector-dominance model were studied. Inconsistencies are found between the assumptions made in the tests and the detailed characteristics of the data. In particular, the density matrix element ρ_{1-1} for ρ^0-meson decay does not show the $\sin^2\theta$ dependence expected (θ is the polar decay angle in the helicity frame), assuming only s- and p-wave $\pi\pi$ interactions. It is concluded that the breakdown of the model has not been established by these tests. (auth)

37796 REGGE-POLE EIKONAL THEORY OF SMALL-ANGLE K_2^0–NUCLEON SCATTERING. Blackmon, Maurice L. (Syracuse Univ., N. Y.); Goldstein, Gary R. Phys. Rev., D; 1: 2707-9(1 May 1970).

A Regge-pole model with absorptive corrections is used to calculate the differential cross sections and polarizations for the reactions $K_{1,2}^0p \to K_{1,2}^0p$ and $K_{1,2}^0p \to K_{1,2}^0p$. (auth)

37797 POMERANCHUK TRAJECTORY AND TOTAL CROSS SECTIONS OF MESON–NUCLEON SCATTERING. Minami, S. (Osaka City Univ.). Lett. Nuovo Cim.; 4: 48-52(11 Jul 1970).

The characteristic properties of the Pomeranchuk trajectory are examined, and the description of πN and KN scattering at high energy is studied taking the Serpukhov data (Phys. Lett., 30 B: 500 (1969)) into consideration. (L.B.S.)

37798 BROKEN-SYMMETRY MASS FORMULAS FOR THE $J^P = \frac{1}{2}^+$ BARYON OCTET FROM S-MATRIX THEORY. Cushing, James T.; Pooch, Udo W. (Univ. of Notre Dame, Ind.). Phys. Rev., D; 1: 2955-61(15 May 1970).

The S-matrix derivation of broken-symmetry mass formulas previously given for the $J^P = 0^-$ octet of pseudoscalar mesons is extended to the octet of $J^P = \frac{1}{2}^+$ baryons. The relation of crossing to the discrete symmetries of C and T (and of Bose statistics) is discussed. (auth)

37799 A STUDY OF FORWARD ELASTIC-SCATTERING PEAKS OF K^+p AND $\bar{p}p$ REACTIONS USING THE DIFFRACTION MODEL. Warty, M. D. (Victoria Jubilee Technical Inst., Bombay). Nuovo Cim.; 67A: 217-24(21 May 1970).

Making use of the diffraction model, it is found that it is possible to understand the shrinking of the K^+p forward elastic-scattering peak. An attempt is made to interpret expanding $\bar{p}p$ elastic-scattering peak, using a similar model with some modification. (auth)

37800 SECONDARY VACUUM TRAJECTORIES AND SCALAR MESON EXCHANGE. Giesecke, J. (Univ., Heidelberg). Z. Phys.; 235: 211-33(1970).

A new second vacuum trajectory passing through $f^*(1515)$ and $\sigma(548)$, $\alpha(t) = -0.3 + t$, is proposed, which, together with $\alpha_{P'}(t = 0) = -0.5$, overcomes the failure of Igi's original superconvergent πN sum rule and avoids the ghost-state of the conventional P′-trajectory. The negative residue at $t = 0$ confirms the repulsive contribution of a vacuum pole component with $J = 0$ to the generalized s-reaction potential, as postulated by Chew (1965). The P- and P′-poles can build the nonresonating background. The Gell–Mann nonsense mechanism at the negative integers with wrong signature explains the dips in the elastic $\pi^{\pm}$ p-scattering at $t = -0.7$, -2.7, and -4.5 (GeV/c)^2. $\sigma(\infty)$ for πN reactions turns out to be 24.3 mb, if $\alpha_p(t = 0) = 1$, but the best fits to the total πN cross sections for pion momenta between 2 and 29 GeV/c yield $\alpha_p(t = 0) = 0.93$. (auth)

37801 CROSS SECTIONS FOR π-p INELASTIC COLLISIONS ACCORDING TO THE REGGEIZED MULTIPERIPHERAL MODEL. Sosnowski, R. (Ecole Polytechnique, Paris); Wroblewski, A. Acta Phys. Pol.; B1: 139-53(Apr-Jun 1970).

The energy dependence of the cross sections for the inelastic π-p collisions is compared with the predictions of the Reggeized multiperipheral model. A good agreement is observed for many reactions. The observed deviations of the experimental points from the calculated curves may be attributed to the production of resonances. (auth)

37802 PADE APPROXIMATION TO THE S MATRIX ABOVE PRODUCTION THRESHOLD FOR PION–NUCLEON SCATTERING IN PSEUDOSCALAR FIELD THEORY. Redei, L. B. (Umea Univ., Sweden). Phys. Rev., D; 1: 3506-10(15 Jun 1970).

The Padé approximation method of calculating the S matrix in pion–nucleon pseudoscalar coupling field theory is discussed above production threshold. It is shown that the evaluation of the Padé approximant to the S matrix, reduces, for c.m. energies below second production threshold, to the solution of an integral equation, with an energy-momentum-conserving kernel on the nucleon two-pion three-body subspace. It is shown that a reduction of this type cannot be expected to hold above the second threshold unless further approximations are made. (auth)

Strong (Baryon No. ≥ 2)

Refer also to abstracts 37721, 37746, 37953, and 38319.

37803 (JINR-P1-3971) NUCLEONS AND PIONS. Proceedings of the First International Colloquium on Nucleon–Nucleon and Pion–Nucleon Interactions, Dubna, June 11–15, 1968. (Joint Inst. for Nuclear Research, Dubna (USSR)). 294p. (In English and Russian). (CONF-680646).

The nucleon–nucleon and π-meson-nucleon interactions at high energies are discussed. New experimental data on nucleon–nucleon and π-meson-nucleon interactions, and new theoretical studies on pion and nucleon physics were analyzed. In the N–N collisions at energies below 1 GeV it was noted that the amplitude of nucleon scattering by nucleons at 50 to 400 MeV at the present time are determined univalued. The problem of univalued phase analysis at small energies and a series of problems related to the disturbance of isotopic invariance at very low energies, were, also, discussed. The experimental studies of np-collisions at 600 to 650 MeV and phase analysis of nn-data indicated that there exist sufficient information offering standard sets of phase shifts. Data on elastic πp-scattering at 240 MeV were evaluated and it was observed that more accurate experiments are required for explicit determination of the nonresonance phases, especially, in

studies of $\pi\pi$-interactions. Phenomenological analysis of (p,p) and (n,p) interactions at up to 750 MeV, the single boson model and low energy p-p scattering tensor meson, and LS forces in elastic n-n scattering, meson-baryon inverse scattering, scattering at large angles and high-energies are covered. The cross section for ρ^0 and N^{*++} formation in the four-prong π^-p-interactions at 10 GeV/c and energy separated particles in inelastic π-N-interections at 17 GeV and proton-nucleon interactions with two identified protons with energy transfer to neutral component at 19.8 GeV/c are analyzed. (R.V.J.)

37804 (NYO-4032-22) ISN'T IT TIME TO CALCULATE THE NUCLEON–NUCLEON FORCE? Brown, G. E. (State Univ. of New York, Stony Brook). Jun 1970. Contract 31-6028B. 10p. Dep. CFSTI.

The possibilities of calculating the nucleon–nucleon force considering one-boson-exchange models are discussed. This discussion covers the ϵ meson in pion-nucleon scattering, including repulsive contributions and pair suppression. It is concluded that the one-boson-exchange models are conceptually inadequate. (J.F.P.)

37805 (RLO-1388-571) UNITARY MODEL OF REGGE CUTS. Dash, Jan W.; Pignotti, A. (Washington Univ., Seattle); Fulco, J. R. (California Univ., Santa Barbara). Oct 1969. 13p. Dep. CFSTI.

A method of generating Regge cuts is proposed which is consistent with full connected unitarity. The results are applied to the recent Serpukhov pp data. (auth)

37806 PERIPHERAL PARTICLE GENERATION AT HIGH ENERGY. Kolkunov, V. A.; Nikolaevskii, E. S.; Ter-Martirosyan, K. A. JETP Lett. (USSR) (Engl. Transl.); 11: 168-71(5 Mar 1970).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 11: 260-4(5 Mar 1970).

It is shown that the spectra of π^-, K^-, and $\bar{p}$, obtained by irradiating aluminum-27 nuclei with 70-GeV protons, are well described by the simple model of peripheral production. The rapid decrease of the spectra with increasing laboratory energy of the particles is a consequence of the decrease of the vertex of the transformation of the proton into the system of final particles in the region of not very large values of its mass. (J.F.P.)

37807 STRUCTURE FUNCTIONS OF THE N COMPONENT OF EXTENSIVE AIR SHOWERS. Zgrablich, G. (Argonne National Lab., Ill.). Phys. Rev., D; 1: 1590-6(15 Mar 1970).

A "pion-links method" is developed to solve the three-dimensional nucleon–pion cascade equations of cosmic rays, and results are computed for showers developing in the atmosphere and in the ionization calorimeter at several values of the primary cosmic-ray energy. (auth)

37808 UNITARY PADE APPROXIMANTS IN STRONG-INTERACTION PHYSICS: THE NUCLEON–NUCLEON SYSTEM. Bessis, J. D.; Graffi, S.; Grecchi, V.; Turchetti, G. (Centre d'Etudes Nucleaires de Saclay, Gif-sur-Yvette, France). Phys. Rev., D; 1: 2064-95(1 Apr 1970).

The unitary Padé approximants, successfully introduced in strong-interaction physics for the pion and kaon systems, are now applied to the nucleon–nucleon problem. It is assumed that the interaction between two nucleons is described by the renormalizable Lagrangian $L_I = ig\bar{\psi}\gamma_5\tau\psi\Phi + \lambda(\Phi\cdot\Phi)^2$. The result of the complete calculation of the [1,1] unitary Padé approximant is presented, which does not involve the second term in the Lagrangian: This implies that no free parameters appear in the model. A complete description of low-energy nucleon–nucleon physics is then obtained which qualitatively and often quantitatively agrees with experiment. Bound states appear only in S waves, and a real pole is found in the deuteron amplitude at 4.8 MeV when the pion–nucleon coupling constant is taken at its physical value $g^2/4\pi = 14.7$. The Regge trajectories rise with energy: The deuteron recurrence does not become physical, while the recurrences of the virtual $^1S_0$ state give rise to narrow resonances in the $^1D_2$ and $^1G_4$ waves. For all waves (with the exception of the $^1S_0$ which in the [1,1] Padé approximation has a wrong threshold behavior), the calculated phase shifts are in good qualitative agreement with the experimental phase-shift analysis. (auth)

37809 PADE APPROXIMANTS IN THREE-BODY CALCULATIONS. Tjon, J. A. (State Univ. of New York, Stony Brook). Contract AT(30-1)-3668B. Phys. Rev., D; 1: 2109-12(1 Apr 1970).

The Faddeev equations are solved by means of Padé approximants. As an application of the method, the doublet and quartet scattering lengths of neutron–deuteron scattering are calculated for the case that the nucleon–nucleon interactions are described by central local Yukawa potentials. (auth)

37810 UNIVERSAL THEORY OF PRIMARY INTERACTIONS, SCALAR MESONS, AND NUCLEON–NUCLEON SCATTERING. Chiang, C. C. (Univ. of Texas, Austin); Gleiser, R. J.; Huq, M. Phys. Rev., D; 1: 2184-90(1 Apr 1970).

The nucleon–nucleon phase shifts are calculated by adding the exchange of the scalar–isoscaler meson ϵ to our previous calculations based on the universal theory of primary interactions proposed by Sudarshan. Some improvements are obtained. In particular, the $1S_0$, $1D_2$, and $3P_2$ results are good for $g_{\epsilon NN}^2/4\pi = 13.5$ and a hard-core cutoff at 0.4 F. (auth)

37811 DIFFRACTION DISSOCIATION. Gombosi, Eva (Central Research Inst. for Physics, Budapest). Magy. Fiz. Foly.; 17: 445-57(1969). (In Hungarian).

The diffraction of a particle on a target is examined. The coherent interaction with the target nucleus is due to the Coulomb field or the nuclear field of the nucleus; accordingly, the cases involved are designated as Coulomb dissociation (CD) or diffraction dissociation (DD). In the latter case the interaction involves a vacuum-pole exchange while in CD a photon is exchanged. DD-type phenomena are often encountered in energy-degenerate systems; this is demonstrated by using a wave-optical analogy. After describing the properties of DD-generated systems, the kinetics of the π + nucleus → nucleus + nπ process are studied. For the experimental study of the DD phenomena, emulsion and bubble-chamber techniques are used. The DD process could clarify the very-high energy jets observed in cosmic radiation. Problems related to the quark model may be resolved after data from the new, higher-energy accelerators become available. (TTT)

37812 VELOCITY WEIGHT FUNCTION F (λ) OF THE THERMODYNAMICAL MODEL AND THE MULTI-REGGE MODEL. Ranft, G.; Ranft, J. (Karl-Marx Univ., Leipzig). Phys. Lett.; 32B: 207-10(22 Jun 1970).

Using the multi-Regge model the velocity weight function U(λ) is calculated which approximately agrees with the empirically determined function F(λ) of the thermodynamical model at energies between 10 and 30 GeV/c except near $\lambda = 0$. Negatively charged particle spectra are represented well at 19.2 GeV/c. U(λ) depends weakly on the primary energy as compared to the energy independence of F(λ). Presently it is not clear how this energy dependence will change if more multi-Regge graphs are included in the calculation of U(λ). (auth)

37813 COHERENT INELASTIC CONTRIBUTIONS TO ABSORPTIVE CORRECTIONS IN A COMPOSITE MODEL. Harrington, David R. (Rutgers–The State Univ., New Brunswick, N. J.). Phys. Rev., D; 1: 2615-19(1 May 1970).

Coherent inelastic contributions to the absorptive corrections in high-energy exchange scattering are studied in a model in which hadrons are taken to be composite systems. General expressions for a momentum-transfer-dependent "λ factor" (i.e., the ratio of the complete absorptive correction to its elastic-only approximation) are obtained, and evaluated for a particular case meant to approximate neutron-proton charge-exchange scattering. In the forward direction, the λ factor is about 1.36 and 1.17 for two- and three-constituent nucleons, respectively. In both cases, however, it decreases rather rapidly with increasing momentum transfer, falling somewhat below 1.0 for momentum transfer squared greater than about 0.5 $(GeV/c)^2$ before beginning to increase again. (auth)

37814 REGGE-POLE EIKONAL THEORY FOR SMALL-ANGLE NUCLEON–NUCLEON AND ANTINUCLEON–NUCLEON SCATTERING. Blackmon, Maurice L. (Argonne National Lab., Ill. Syracuse Univ., N. Y.); Goldstein, Gary R. Phys. Rev., D; 1: 2675-82(1 May 1970).

An eikonal model is presented for the small-angle high-energy scattering of nucleons and antinucleons on nucleon targets. The model uses a flat Pomeranchon with a residue function given by a squared dipole. Exchange-degenerate trajectories and residue functions for the three pairs of Regge poles (the ω and P', the ρ and A_2, and the π and B) are also used. Using previous work by Arnold and Blackmon and other work by the present authors to fix trajectories and relative sizes of residue functions, it is found that the model satisfactorily describes elastic scattering. An interpretation is given of the secondary maximum in the differential cross section of $\bar{p}p$ scattering which occurs around $-t \approx 0.9\ GeV^2$. A crossover is found in the differential cross sections of pp and $\bar{p}p$ elastic scattering, and results for various polarizations are shown. The np → pn and $\bar{p}p$ → $\bar{n}n$ are also discussed, which are not described satisfactorily by the model. (auth)

37815 INELASTIC PROCESSES IN THE EIKONAL EXPANSION. Rudin, Robert A. (Rutgers–The State Univ., New Brunswick, N. J.). Phys. Rev., D; 1: 2557-64(1 May 1970).

Glauber's eikonal approximation for multiple scattering is ex-

tended to include inelastic processes. It is found that inelastic contributions to the differential cross section for the reaction $\pi^-d \to \pi^-d$ are negligible, while such contributions dominate the double-charge-exchange reaction $\pi^-{}^3He \to \pi^+3n$. (auth)

37816 K^- CAPTURE IN ^4He IN THE MULTIPLE-IMPULSE APPROXIMATION. Wienke, B. R. (Northwestern Univ., Evanston, Ill.). Phys. Rev., D; 1: 2514-22(1 May 1970).

The process $K^- + {}^4He \to \Lambda + \pi^- + {}^3He$ is analyzed in the multiple-impulse approximation for both 1S and 2P atomic capture at rest. Reaction kinematics and rates, which are free of arbitrary constants, are calculated in both first and second order. The multichannel $\bar{K}n$ amplitudes of Kim are employed to incorporate the $Y_1^*(1385)$ resonance into the first-order (direct) term, and both the $Y_1^*(1385)$ and $Y_0^*(1405)$ resonances into the second-order (Σ-Λ conversion) term. Agreement with experiment is good, particularly when the conversion term is added. (auth)

37817 SATURATION OF SUPERCONVERGENT DISPERSION SUM RULES FOR pp-SCATTERING. Lendel, A. I.; Lend'el, V. I. (Uzhgorod State Univ., USSR). Ukr. Fiz. Zh.; 15: 833-4(May 1970). (In Russian).

Superconvergent dispersion sum rules for pp-scattering were analyzed. The rules were obtained previously and in the present work. Only one of these rules of sums is satisfied. The type of two others testifies to the fact that these sum rules are not saturated with low-energy $\pi\pi$-resonances. (auth)

Particle Invariance Principles and Symmetries

General

Refer also to abstracts 37864 and 37883.

37818 (CALT-68-259) BROKEN SCALE INVARIANCE AND SCALING LAWS IN ELEMENTARY PARTICLE PHYSICS. Callan, Curtis G. Jr. (California Inst. of Tech., Pasadena). [nd]. Contract AT(11-1)-68. 16p. (CONF-700419-1). Dep. CFSTI.

From Meeting of the American Physical Society, Washington, D. C.

In order to implement a previous suggestion that scale invariance might be useful as a broken symmetry, the method of scaling laws is described. This method provides a systematic way of extracting observable consequences from specific assumptions about the breaking of scale invariance. (J.F.P.)

37819 (UR-875-311) SINGULARITY STRUCTURE OF BROKEN CHIRAL SYMMETRY. Okubo, S.; Mathur, V. S. (Rochester Univ., N. Y. Dept. of Physics and Astronomy). 19 Jun 1970. Contract AT(30-1)-875. 32p. (CONF-700806-10). Dep. CFSTI.

From 15th International Conference on High Energy Physics, Kiev, USSR.

General properties of the Gell-Mann model for chiral W(3) and SW(3) symmetry breakings were investigated. From a study of the two point functions, it was concluded that the theory may have singular points as a function of the coupling parameter which breaks the symmetry, provided that in the exact SW(3) limit the symmetry is realized through the emergence of Goldstone bosons. This conclusion is independent of dynamical details and depends only upon general principles currently accepted. The compatibility of the theory with the transformation recently discovered by Kuo is shown to arise partly due to the presence of such singular points. A detailed investigation based upon both linear and nonlinear realizations of the chiral group shows that physical quantities such as masses and scattering amplitudes need not be manifestly invariant under the Kuo transformation which is represented as a highly singular operation in the case of the nonlinear theory. (auth)

37820 CHIRAL DYNAMICS, GAUGE FIELDS, AND ELEMENTARY PARTICLE PHYSICS. Majumdar, Deba Prasad. Stong Brook, N. Y.; State Univ. of New York (1969p. 132p.

Thesis.

Chiral dynamic transformation properties are described and an SU(3) ⊗ SU(3) nonlinear chiral dynamic Lagrangian is developed for the pseudoscalar mesons. For the π and K mesons its properties are similar to those of Cronin's model; but for the strong decay $\chi^0 \to \eta\pi\pi$ it has an energy asymmetry in the Dalitz plot. This could explain the presently available experimental data. The construction of this Lagrangian, the decay rate and the energy asymmetry of the η particle observed for the process $\chi^0 \to \eta\pi\pi$ are discussed in detail. Vector and axial-vector mesons are studied as gauge fields in an SU(3) ⊗ SU(3) real σ-model. First the Lee, Weinberg and Zumino model with symmetry breaking is investigated for the general matter field. However, the notion of field-current identity is preserved throughout this work. Generalized Weinberg sum rules for the spectral functions of currents are discussed in the context of the algebra of fields when both the mass breaking and the kinetic energy breaking are present. Some of these sum rules are studied with the help of the vector meson dominance hypothesis. The consequences of this broken-symmetry gauge-field model for some physical processes are then considered. For this purpose a model is discussed where both the scalar and the pseudo-scalar mesons are assumed to exist and are given by chiral dynamics. The renormalization of the spin-zero and the spin-one fields due to mixing and symmetry breaking is described. Expressions for the vector and the axial-vector currents are derived in terms of the renormalized fields. The model is then applied to explain some physical phenomena. Expressions of experimentally measurable quantities are first derived for the general case of simultaneous mass breaking and kinetic energy breaking. The results of each of these kinds of gauge field models are then studied separately. Mainly two areas are investigated. These are the strong decays of the vector mesons and the weak K_{l3} decays. Among the vector meson decays only $\rho \to \pi\pi$ and $K^* \to \kappa\pi$ are discussed. These decay rates and the K_{l3} form factors form a consistent picture in this model. In the context of the general model it is found that the Glashow–Weinberg relation for $f_+(0)$ in K_{l3} decays is exact up to second order in SU(3) ⊗ SU(3) symmetry breaking. Expressions for the corrections to the K_{l3} form factors due to the existence of the scalar mesons are derived. (Diss. Abstr. Int., B)

37821 COMPLEX QUATERNION REPRESENTATION OF PROPER LORENTZ TRANSFORMATIONS. Thielheim, K. O. (Institut fuer Reine und Angewandte Kernphysik, Kiel). Z. Naturforsch.; 24a: 1858(Nov 1969).

The complex quaternion representation of proper Lorentz transformations is case in a form useful for applications. (J.F.P.)

37822 PHYSICAL CONTENT OF FORMALISM FOR THE QUASI-STOCHASTIC SEMIGROUPS OF RELATIVISTIC ENDOMORPHISMS. Yudin, V. V.; Ershov, A. D. (Far Eastern State Univ., Vladivostok, USSR). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 4, 157-8(1970). (In Russian).

A mathematical formalism was previously developed for the quasi-stochastic semigroup of relativistic endomorphisms (QSRE) and physical properties, as the result of the semigroup quasi-stochastic forms of relativistic invariance principle (RIP) were analyzed. An attempt was made of correlating two forms of RIP in order to determine the physical basis for development of such forms. The correlations and mathematical analysis showed that the principle of relativistic invariance may exist in two forms: one as a Lorentz invariance which its physical expression in the terms and concepts of electromagnetic (boson) field and another in the form of quasistochastic invariance with the fermion content. It was assumed that the QSRE corresponds to the empirical situation with the neutron field acting as the data carrier. (R.V.J.)

37823 ROTATION AND LORENTZ SYMMETRIES OF SCATTERING AMPLITUDES. Wang, Kuo-hsiang (Univ. of California, Berkeley). Phys. Rev., D; 1: 1754-63(15 Mar 1970).

A general study of the space-time symmetries of the scattering amplitude is made. The scattering amplitude in the c.m. frame has O(2,1) symmetry in the physical regions of the crossed channels. By working in this frame, the same definition of the helicity, as that used in the usual angular momentum analysis can be used. For the pairwise equal-mass case, the helicity amplitude in the forward scattering region of the crossed channels has O(2,2) symmetry in the c.m. frame, and O(3,1) symmetry in the brick-wall frame. An O(2,2) expansion is applied to a multiparticle system. The O(4) expansion in the brick-wall frame is also continued into the O(3,1) region, and the equivalence is shown between the O(4) expansion and the O(3,1) expansion. Finally, the difference between the implications of the three-dimensional and four-dimensional symmetries is pointed out. (auth)

37824 BROKEN CHIRAL SYMMETRY. I. CONTINUOUS TRANSITIONS BETWEEN SUBGROUPS. Okubo, S.; Mathur, V. S. (Univ. of Rochester, N. Y.). Phys. Rev., D; 1: 2046-57 (1 Apr 1970).

The general properties of the Gell-Mann model are investigated. From a study of the two-point functions, it is found that the symmetry-breaking parameters cannot assume arbitrary values, but must be confined in specified domains. The boundaries of these domains are related to several interesting subgroup symmetries. Arguments are presented to show that one must have essential singularities at those values of the symmetry-breaking parameter which correspond to subgroup symmetries realized via the emergence of zero-mass bosons. In a suitable singularity-free range of physical interest, the possibility of continuous transitions

between different symmetry subgroups is discussed, and it is shown how, with the use of a variational principle, some mass formulas and relations between other physically relevant quantities can be obtained in a nonperturbative manner. In particular, the relation obtained by Gell-Mann, Oakes, and Renner for the symmetry-breaking parameter is obtained naturally in this manner. Also, it is shown that this formalism requires the existence of scalar mesons. (auth)

37825 SATURATION OF A CHIRAL CHARGE-CURRENT COMMUTATOR WITH REPRESENTATIONS OF $SU(6)_W \otimes O(3)$. Tjia, M. O. (Northwestern Univ., Evanston, Ill.); Albright, C. H. Phys. Rev., D; 1: 2286-2308(15 Apr 1970).

The saturation of the charge-current equal-time commutation relation $[F_\alpha^5(x_0), I_\beta^5(x)] = if_{\alpha\beta\gamma} I_\gamma \delta(x)$ in the infinite-momentum frame is studied by employing a pure as well as a mixed configuration of $SU(6)_W \otimes O(3)$. The consistency of such finite saturation schemes for the above commutator are examined in comparison with the corresponding charge-charge commutator. The study shows, as expected on heuristic grounds, that the consistency requirement cannot be fulfilled over the entire range of the momentum transfer q. It is also discovered that the unitary-symmetric and -antisymmetric combinations of the above commutator display different degrees of contradictions: The former admits only a zero "range of consistency," while the latter yields a family of sum rules near q = 0, which offer predictions for the zero-q^2 intercepts and slopes of the various form factors involved. Among these are found the disturbing results $\mu'(p) = \mu'(n) = \mu^*(N^*) = 0$, whereas others have yet to be tested experimentally. It is shown that even a substantial extension of the saturation scheme fails to induce visible improvement in the consistency problem. While the sum rules appear to show some response to the admixture, many of the results remain unaffected. A closer investigation of these problems suggests the desirability of considering modified transformation properties for the local current operators as an alternative approach to the present problem. (auth)

37826 ASYMPTOTIC LOCALITY AND THE STRUCTURE OF LOCAL INTERNAL SYMMETRIES. Landau, Lawrence J. (Univ., Hamburg). Commun. Math. Phys.; 17: 156-76(1970).

Symmetries are investigated from the local viewpoint. Using the Haag-Ruelle construction, the action of a local internal symmetry on the asymptotic states is determined. A condition of "asymptotic locality" is derived and used to show that the symmetry acts linearly and locally on the asymptotic fields. Within a field theoretical framework it is shown that the internal symmetry must commute with the Poincaré group. The general structure of an internal symmetry is determined. The uniqueness of the representation of the Poincaré group is discussed, and a simple example of an infinite component field is given to indicate what occurs when there are infinitely degenerate particle multiplets. (auth)

37827 PERTURBATION-SUSTAINED SYMMETRY: AN ALTERNATIVE TO BROKEN SYMMETRY. Woo, C. H. (Univ. of Maryland, College Park). Phys. Rev., D; 1: 1686-92(15 Mar 1970).

There are no known internal symmetries of the isospin invariance variety that are exact. The viewpoint that the "perturbing interactions," usually considered the cause of the "breaking" of internal symmetries, are actually also responsible for the existence of any internal symmetry at all is studied. Consequently, the symmetries are "born imperfect." Simple examples which give concrete expressions to this hypothesis are studied, and the emergence of two fermion fields with opposite charges from one field upon perturbation is investigated. The implication of these considerations for electromagnetic-mass-difference calculations is discussed. (auth)

37828 NEW DYNAMICAL GROUP FOR THE RELATIVISTIC QUANTUM MECHANICS OF ELEMENTARY PARTICLES. Aghassi, J. J.; Roman, P.; Santilli, R. M. (Boston Univ.). Phys. Rev., D; 1: 2753-65(15 May 1970).

Nonrelativistic Galilean quantum mechanics and the standard transition to relativistic Poincaré quantum mechanics is analyzed in terms of group theory. Special emphasis is given to the discussion of the relation between dynamics and geometry. Certain unsatisfactory features are pointed out and a new relativistic group G_5 is suggested as the symmetry group of dynamics. G_5 contains both the nonrelativistic Galilei group and the Poincaré group as subgroups, and it is a group extension of the restricted Lorentz group. For use in relativistic quantum mechanics, the central extension of G_5 by a phase group must be employed. The Lie algebra of this relativistic quantum-mechanical Galilei group $\tilde{G}_5$ contains an acceptable covariant space-time position operator and a nontrivial relativistic mass operator. The latter also serves to describe dynamical development. The irreducible unitary projective representations of $\tilde{G}_5$ correspond to infinite towers of states with increasing spin. (auth)

37829 O(2,1) DECOMPOSITION OF THE EQUAL-MASS MULTIPERIPHERAL EQUATION AT t = 0. Ciafaloni, Marcello; DeTar, Carleton (Univ. of California, Berkeley). Phys. Rev., D; 1: 2917-30(15 May 1970).

The results of a group-theoretical analysis of the t < 0 multiperipheral equation is extended to the case t = 0 for pairwise equal masses. Using variables previously discussed, the equation in the Bali-Chew-Pignotti (BCP) model is diagonalized with respect to the O(2,1) group and the solutions are related to the equation so obtained with the solutions obtained after diagonalization with respect to the O(3,1) group. Poles in the O(3,1) partial-wave amplitude give rise to the expected sequence of daughter poles in the O(2,1) partial-wave amplitude. At general momentum transfer, factorization is established at the O(1,1) poles in the decomposition of the BCP amplitude, and further simplifications to the diagonalized equations based upon this model are presented. (auth)

37830 UNIFIED APPROACH TO THE REPRESENTATIONS OF GROUPS SU(2) AND SU(1,1). Young, K.-C. (McGill Univ., Montreal). Can. J. Phys.; 48: 1272-82(15 May 1970).

A unified approach to the representations of groups SU(2) and SU(1, 1) is made. The method is based on the observation that SU(2) and SU(1, 1) can be considered as special cases of a group G(a). The representation of G(a) is realized in the space of homogeneous generalized functions. The canonical bases of the unitary irreducible representations are constructed explicitly. The matrix elements for the finite transformation are found. Explicit expressions for the Wigner coefficients are also obtained. (auth)

37831 RELATIONSHIP BETWEEN NONLINEAR AND LINEAR REALIZATIONS OF CHIRAL SU(2) x SU(2): THEORY AND APPLICATIONS. Rosen, S. P. (Purdue Univ., Lafayette, Ind.). Phys. Rev., D; 1: 3392-3402(15 Jun 1970).

The problem of converting nonlinear realizations of SU(2) × SU(2) has been approached in three different ways. Weinberg has introduced a matrix $\Lambda(\pi)$ with well-defined properties under infinitesimal chiral transformations and has shown that it can be used to linearize nonlinear fields. Coleman, Wess, and Zumino have achieved the same result by treating the pion fields as parameters of finite chiral rotations; and the present author has made use of the fact that linear realizations are eigenstates of the Casimir operators and close upon themselves under the action of chiral operators. Here it is shown that the three approaches are equivalent to one another. The most general expression is calculated for $\Lambda(\pi)$, and it is shown that certain of its matrix elements have the desired properties with respect to the Casimir and chiral operators. It is then shown that the method of Coleman, Wess, and Zumino is a special case of $\Lambda(\pi)$. In the course of the analysis, it is found that $\Lambda(\pi)$ is manifestly covariant under redefinitions of the pion field. To illustrate the usefulness of converting nonlinear fields to linear forms, π-π scattering lengths are calculated and weak currents are constructed for meson decay. (auth)

Applications (Electromagnetic and Weak)

Refer also to abstracts 37615, 37720, 37734, 37772, and 37831.

37832 (ITF-70-29) ON THE T NONINVARIANT TWO-COMPONENT EQUATION FOR NEUTRINO. Fushchich, V. I. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1970. 14p. Dep. CFSTI (U. S. Sales Only).

The relativistic two-component equation describing free motion of a particle with the zero mass and spin $\frac{1}{2}$ P-, T- noninvariant but C-invariant is found. The representation of the Poincaré group for the zero mass and discrete spin is constructed. The position operator for such a particle is defined. (auth)

37833 (PURC-2137-23) CP VIOLATION AND REGENERATED K_S^0 DECAY. Technical Report No. 6. Strovink, Mark W. (Princeton Univ., N. J. Elementary Particles Lab.). 23 Mar 1970. Contracts AT(30-1)-2137; N00014-67A0151-0001. 112p. Dep. CFSTI.

Thesis.

With a wire-spark-chamber spectrometer, about 287 000 K_{e3} decays downstream of a 9.125-inch Cu regenerator were reconstructed. The observed asymmetry between e^+ and e^- events was normalized by a corresponding sample of free decay data. The regeneration phase in Cu at a mean momentum of 2.2 GeV/c has been found to be $\arg[i(f-\bar{f})] = -63.5^0 \pm 8.3^0 - 149^0(|\delta| - 0.468)$ with δ the K_1^0-K_2^0 mass difference in units of the K_1^0 decay rate. This value includes a correction of $-10.8^0 \pm 4.6^0$ for the effect of diffractive and inelastic regeneration. By a unique method, this correction largely was determined from the data itself. Combination of part of the K_{e3} data with existing $K_{\pi 2}$ results has given, for the phase of the CP-violating amplitude ratio $\eta_{+-} \phi_{+-} =$

$43.1^0 \pm 10.9^0$ in agreement with the "vacuum regeneration" measurements. The relation between the observed amplitude of the K_{e3} asymmetry and the $\Delta S = \Delta Q$ selection rule also was examined. (auth)

37834 (RLO-1388-577) DEEP INELASTIC ELECTROPRODUCTION AND CONFORMAL SYMMETRY. Boulware, David G.; Brown, Lowell S.; Peccei, R. D. (Washington Univ., Seattle. Dept. of Physics). [1969]. Contract AT(45-1)-1388. 28p. Dep. CFSTI.

Motivated by the observed scale invariance of high energy inelastic electron-proton scattering, the constraints on a Compton amplitude that follow if it is invariant under the full group of conformal coordinate transformations are studied. Although the conformal group contains operations that interchange space-like and time-like coordinate intervals, a large class of manifestly causal amplitudes can be constructed. It is found that the strict application of conformal symmetry reduces the number of independent covariants from four to two in the case of a spin zero target. The two covariants of the conformal Compton amplitude remain independent when it is restricted to forward scattering. Hence invariance under the full conformal group yields no constraints on the structure functions of inelastic electron scattering other than that already provided by simple dilation invariance. (auth)

37835 POINCARE-LIKE GROUP ASSOCIATED WITH NEUTRINO PHYSICS, AND SOME APPLICATIONS. Flato, Moshe (College de France, Paris); Hillion, Pierre. Phys. Rev., D; 1: 1667-73(15 Mar 1970).

An inhomogeneous Lorentz group (different from the Poincaré group) is studied in relation with the relativistic covariance of the Dirac–Weyl equation. A mathematical study of the group structure and of its unitary irreducible representations is presented, and physical consequences concerning neutrino physics (and electromagnetic field) are drawn by the introduction of the Stokes parameters. (auth)

37836 ASYMPTOTIC SYMMETRY, PARTICLE MIXING, AND K_{l3}-DECAY BRANCHING RATIOS. Oneda, S. (Univ. of Wisconsin, Milwaukee); Umezawa, H.; Matsuda, Seisaku. Phys. Rev. Lett.; 25: 71-3(6 Jul 1970).

A concept of asymptotic symmetry is formulated and applied to the determination of mixing parameters between the π^0, η^0, and $\eta'^0(958)$ in broken SU(3) and SU(2) symmetries. One of the solutions gives rise to a rather large violation of the $|\Delta I| = \frac{1}{2}$ rule in the K_{l3} decays which is not inconsistent with present experiment. (auth)

37837 BROKEN CHIRAL SYMMETRY. II. NUMERICAL SOLUTIONS AND η-X MIXING. Mathur, V. S.; Okubo, S.; Rao, Subba J. (Univ. of Rochester, N. Y.). Phys. Rev., D; 1: 2058-64(1 Apr 1970).

Sum rules of the preceding paper together with appropriate SW(2) and broken SU(3) relations were solved numerically in the pole-dominance approximation. In this way, all relevant parameters entering in the theory, including η-X mixing effects, were computed. As applications, $\eta \to 2\gamma$, $X \to \eta 2\pi$, $X \to 2\gamma$, and $X \to 2\pi\gamma$ decay rates are calculated. (auth)

37838 CHIRAL-SYMMETRY BREAKING IN K_{l4} DECAY. de Alwis, S. P. (Univ. of Toronto). Phys. Rev., D; 1: 2131-4 (1 Apr 1970).

An expression is derived for a K_{l4} form factor correct to first order in chiral-symmetry breaking. The corrections seem to be of the correct sign. (auth)

37839 CONSEQUENCES OF UNITARITY IN SOME MODELS OF CP VIOLATION. Gronau, M. (Tel Aviv Univ., Israel); Ne'eman, Y. Phys. Rev., D; 1: 2190-1(1 Apr 1970).

Using the model-dependent assumption of 2π saturation of the unitarity sum, estimates are found for $|\eta_{00}/\eta_{+-}|$ and $\mathrm{Re}\,\epsilon/|\eta_{+-}|$ for a certain class of theories. Two models are teste , and $|\eta_{00}/\eta_{+-}|$ is found to be different from the originally estima d value, which was based on Re_ϵ as input. (auth)

37840 LEPTON–HARDRON DEEP-INELASTIC SCATTERING, GLUON MODEL, AND REGGEIZED SYMMETRY BREAKING. Brandt, Richard A.; Preparata, Giuliano (Rockefeller Univ., New York). Phys. Rev., D; 1: 2577-80(1 May 1970).

A numerical estimate is made of the expectation value between baryons of the equal-time commutator $[J_i^3, J_j^3]$ of $U(3) \oplus U(3)$ currents on the gluon model by using a symmetry-breaking theory based on Regge-pole dominance. The result is in excellent agreement with the electroproduction data. (auth)

37841 BROKEN CHIRAL SU(3) × SU(3) SYMMETRY. I. MESON DECAYS AND K_{l3} FORM FACTORS. Nieh, H. T.; Tsao, H. S. (State Univ. of New York, Stony Brook). Contract AT(30-1)-3668B. Phys. Rev., D; 1: 2663-75(1 May 1970).

Broken chiral SU(3) × SU(3) symmetry is considered by extending the Glashow-Weinberg-Bardeen-Lee scheme to include spin-1 mesons. Vector-meson decays and K_{l3} decays are treated on the basis of the resultant Lagrangian. Numerical estimates are made on the assumption of nonet symmetry, at the SU(3) level, for the spin-1^- mesons. It is found that $F_K/F_\pi \simeq 1.10$, $f_+(0) \simeq 0.96$, $\xi = f_-(0)/f_+(0) \simeq -0.048$, $\lambda_+ \simeq 0.022$, and $\xi\lambda_- \simeq -0.002$. (auth)

37842 MUON CAPTURE, RADIATIVE PION CAPTURE, AND PHOTOPRODUCTION OF CHARGED PIONS IN DOUBLE-CLOSED-SHELL NUCLEI. Cannata, F. (Scuola Normale Superiore, Pisa, Italy). Lett. Nuovo Cim.; 4: 75-9(11 Jul 1970).

The consequence of SU(4) breaking for muon capture total rates in double-closed-shell nuclei are analyzed with sum rule techniques and compared with the quasi-particle theory of Migdal. The analysis is then extended to photoproduction of charged pions in double-closed-shell nuclei where Migdal's theory is not consistent with experimental data. It is shown that sum rule techniques, at variance with Migdal's method, bring theoretical calculations with impulse approximation and Butler surface model production in agreement with experimental values up to about 20%. (L.B.S.)

37843 NEW UNITARITY BOUNDS ON (K_L/K_S). Fischbach, E.; Nieto, M. M. (Univ. of Copenhagen). Nuovo Cim.; 68A: 207-12 (21 Jul 1970).

By using unitarity, all CP-violating theories are grouped into two classes depending on whether a particular sum of terms is a) ≤ 0 or b) >0. In the first case, a stricter upper bound to $|\alpha| = |\langle K_L/K_S\rangle|$ is obtained while, in the second case, a new lower bound to $|\alpha|$ is obtained. A discussion is given with reference to experimental data and the Wu-Yang triangle. (auth)

37844 TENSOR OPERATORS OF RANK TWO FOR THE HOMOGENEOUS LORENTZ GROUP. Ruehl, W. (CERN, Geneva). Nuovo Cim.; 68A: 213-34(21 Jul 1970).

A formula is suggested for the decomposition of a covariant operator which transforms as an arbitrary finite-dimensional representation of $SL_{2,C}$ into a direct integral of irreducible covariant operators. An earlier proof of this formula for four-vector operators is extended to symmetric and antisymmetric rank-two tensor operators. The matrix elements of all irreducible rank-two tensor operators are tabulated. Finally the results are generalized for the group $SL_{2,C}$ extended by parity. (auth)

37845 BROKEN CHIRAL SYMMETRY. III. SW(3) THEORY AND SOFT-PION CORRECTIONS. Mathur, V. S.; Okubo, S. (Univ. of Rochester, N. Y.). Phys. Rev., D; 1: 3468-79(15 Jun 1970).

Starting with the SW(3) group as the fundamental symmetry group, a theory is developed for the continuous breaking of this symmetry, in analogy with the theory based on the W(3) group discussed earlier. Despite what appears at first sight, there are considerable differences in the two theories, and in the present case one can avoid many difficulties associated with the W(3) theory. Several refinements of the arguments given earlier are also presented, which lead to mass formulas for π and K as well as the η meson. A method to calculate finite-mass corrections to soft-pion theorems is also proposed and applied to a few problems. (auth)

Applications (Strong)

Refer also to abstracts 37769, 37772, 37776, and 37831.

37846 (CALT-68-254) HADRON SYMMETRY FROM CROSSING RELATIONS. Rosner, Jonathan L. (California Inst. of Tech., Pasadena). [1970]. Contract AT(11-1)-68. 57p. (CONF-700419-2). Dep. CFSTI.

From Meeting of the American Physical Society, Washington, D. C.

The discussion of hadron symmetry from crossing relations reviews the quark model for the consistency between low-energy and high-energy descriptions of hadron scattering, exchange degeneracies, predictions, results on spins, and recent experiments on total cross sections at higher energies and regarding exotic states. (J.F.P.)

37847 CHIRAL-SYMMETRY MODEL. Kyriakopoulos, E. (Univ. of Chicago). Phys. Rev., D; 1: 1697-1716(15 Mar 1970).

A chiral-symmetry model is constructed in which the vector mesons (which are not introduced by means of the Yang–Mills technique) are described in terms of an antisymmetric second-rank tensor $T_{\mu\nu}$. As a result, the interaction Hamiltonian in the interaction representation contains additional contact-type terms. Besides the pseudoscalar and vector-meson nonets, the model contains two nonets with $J^{PC} = 0^{--}$ and 1^{-+}. Their fields appear

in even numbers in all terms in the expansion of our Lagrangians. A mass Lagrangian is introduced such that the mesons get their physical masses. This gives generalized partially conserved axial-vector current if higher-order contributions are neglected. A $U(3)_{left} \otimes U(3)_{right}$-invariant Lagrangian is found which gives the well-known PPV coupling and also a PVV coupling. A nonet of baryons is introduced, with the $Y_0^*(1405)$ as ninth baryon. Several chiral-invariant meson-baryon Lagrangians are considered, such that the nonderivative and derivative couplings of the pseudoscalar mesons to baryons, and the vector and tensor couplings of the vector mesons to baryons, are obtained. Also, two symmetry-breaking meson-baryon Lagrangians are needed to give the baryons their physical masses. The coupling constant of the tensor coupling of the ρ mesons to nucleons is correctly predicted. The width of the $Y_0^*(1405)$ and the ratio $|G_{NK\Upsilon}|/|G_{\Sigma\pi\gamma}|$ are predicted to be 62 MeV and 2, respectively, which are close to the experimental values. The decay widths $\Gamma[\eta'(958) \rightarrow \eta + 2\pi]$, $\Gamma(K^* \rightarrow K\pi)$, and $\Gamma(\varphi \rightarrow K^+K^-)$ are in reasonable agreement with experiment. (auth)

37848 GENERALIZED MACDOWELL SYMMETRY AS A CONSEQUENCE OF CT INVARIANCE. Georgelin, Y. (Univ. Catolica, Rio de Janeiro). Phys. Rev., D; 1: 1782-5(15 Mar 1970).

Using Joos–Weinberg fields, a Lehmann–Symanzik–Zimmermann reduction formalism, and assuming sufficient analyticity, it is shown that the S-matrix elements for processes involving any number of particles with arbitrary spins admit a MacDowell symmetry as a consequence of CT conservation (or maximum CT violation). (auth)

37849 SPINLESS MESONS IN THE CHIRAL-SYMMETRY SCHEME. Cicogna, G. (Univ., Pisa, Italy). Phys. Rev., D; 1: 1786-90(15 Mar 1970).

The multiplet of the pseudoscalar mesons K, π, η, and η' with their scalar partners is analyzed as a reducible representation of chiral $SU_2 \otimes SU_2$. A spontaneous breaking mechanism of this symmetry is introduced, leaving isospin and hypercharge as residual invariance. Also in this scheme a Lagrangian model is considered, which exhibits various remarkable group-theoretical properties, and leads to numerical values, mass, and mixing-angle relations, in very good agreement with experimental data. (auth)

37850 ALGEBRAIC REALIZATION OF WEINBERG'S SUPERCONVERGENCE CONDITIONS. Noga, M. (Purdue Univ., Lafayette, Ind.); Cronstroem, C. Phys. Rev., D; 1: 2414-20(15 Apr 1970).

The algebraic realization of a pair of sum rules proposed by Weinberg for forward scattering of massless pions is investigated for the case when only p-wave pions are taken into account. It is shown that the algebraic structure of the first superconvergence condition is given by the Lie algebra of the group $SU(2) \otimes SU(4)$. A few p-wave pion decay widths are calculated and found to agree satisfactorily with experiment. It is further shown that the mass spectra obtained from the second superconvergence condition are unsatisfactory, as they predict that the hadron masses decrease with increasing isospin (or spin). Various possible reasons for this defect are discussed. (auth)

37851 GROUP-GEOMETRICAL FORMULATION OF AN SU(3) x SU(3) EFFECTIVE LAGRANGIAN. Finkelstein, R. (Univ. of California, Los Angeles); Staunton, L.; Hilgevoord, J. Phys. Rev., D; 1: 2832-45(15 May 1970).

An $SU(3) \times SU(3)$ effective Lagrangian, generated by a massive vector field, was formulated with the aid of a group-geometrical method. This formalism is manifestly invariant under nonlinear transformations, and permits an exact and compact treatment of the nonlinearities. The $SU(3) \times SU(3)$ treatment incorporates only those minimal departures from $SU(2) \times SU(2)$ that are required to secure a reasonable model, and the new Lagrangian contains no free parameters not already present in the $SU(2) \times SU(2)$ model. These parameters are determined by fitting the linearized theory to the pion-nucleon system. Results for other members of the octets, such as the Callan-Treiman formula, are then in satisfactory agreement with experiment or with the current algebra. It is hoped that the formalism will permit the treatment of the nonlinearities to be extended beyond the discussion of the tree diagrams. (auth)

37852 RENORMALIZATION OF AN $SU(3) \otimes SU(3)$ CHIRAL-INVARIANT σ MODEL. Crater, Horace W. (Inst. for Advanced Study, Princeton, N. J.). Phys. Rev., D; 1: 3313-19(15 Jun 1970).

The single-loop charge renormalization of an $SU(3) \otimes SU(3)$ chiral-invariant σ model is examined. This requires that a systematic way of treating charge renormalization for models with the added complexity of SU(3) be developed. The model considered has two nonderivative four-point couplings and one non-derivative three-point coupling. It is found that two of these three independent chiral-invariant couplings are not individually renormalizable, as their higher-order SU(3) structure is not expressible in terms of the SU(3) structure of their respective tree diagrams. Only when all three invariant couplings are considered simultaneously is the resultant SU(3) structure given by the tree diagrams. Hence, each of the three charge renormalization constants is a function of all three coupling constants. (auth)

37853 CONTRACTED COMMUTATORS AND THE SU(6) DESCRIPTION OF THE HADRON SPECTRUM. Michel, Louis (Institut des Hautes Etudes Scientifiques, Bures-sur-Yvette, France); Ne'eman, Yuval. Phys. Rev., D; 1: 3519-20(15 Jun 1970).

It is shown that the assumption of vanishing commutators between space components of currents is incompatible with the conjecture connecting the observed SU(6)-like hadron spectrum with the algebra of the currents and its contraction. (auth)

Field Theories

General

Refer also to abstracts 37407, 37668, and 37681.

37854 NEW DEFINITION OF CURRENTS IN BORN–INFELD ELECTROMAGNETISM. Poletti, Pierre (Inst. Henri Poincare, Paris). Compt. Rend., Ser. A; 270: 978-80(13 Apr 1970). (In French).

In the Born–Infeld electromagnetism theory, a complex formalism is introduced which gives a Maxwellian form to the equations of the theory and leads to symmetrical definitions of the magnitudes. An expression of the currents as functions of the fields is deduced in the particular case of electrostatics. (France)

37855 DILATATION SYMMETRY OF CLASSICAL ELECTRODYNAMICS WITH CHARGED PARTICLES OF FINITE MASS. Garrod, Claude (Univ. of California, Davis). Phys. Rev., D; 1: 1524-6(15 Mar 1970).

It is shown that classical electrodynamics with charged particles of finite mass is invariant with respect to a one-parameter group of "dilatation transformations" if the theory is expressed in covariant Hamiltonian form. The "mass transformations," which seem somewhat puzzling in the usual discussions of this invariance group, appear in a natural way. A corresponding conservation law is derived and discussed. (auth)

37856 NEW GAUGE CONDITION DEDUCED FROM THE STUDY OF THE NONRADIATIVE ELECTROMAGNETIC FIELD IN SPECIAL RELATIVITY. Bredimas, Antoine (Paris Univ.). Compt. Rend., Ser. A; 270: 1130-3(27 Apr 1970). (In French).

It has been demonstrated by A. Papapetrou that the nonradiative electromagnetic field is of the form: $F_{\mu\nu} = \Sigma_{n\geq 1}(1/r^n)F^n_{\mu\nu}(u, \xi^i)$. Here, the gage condition that gives the same structure to the components of the potential four-vector corresponding to such a field is established. (auth) (France)

37857 GEOMETRODYNAMICS OF ELECTROMAGNETIC FIELDS IN THE NEWMAN-PENROSE FORMALISM. Ludwig, Garry (Univ. of Alberta, Edmonton). Commun. Math. Phys.; 17: 98-108(1970).

The "already unified" field theory of Rainich, Misner, and Wheeler is rederived in the spin-coefficient formalism of Newman and Penrose. Conditions equivalent to the Rainich algebraic conditions are obtained by classifying the tracefree Ricci tensor according to its principal null directions. The case of a null electromagnetic field is also treated fully. Necessary and sufficient conditions are given for a Riemannian geometry to have an electromagnetic field, null or nonnull, as its source. (auth)

37858 CLASSICAL, STABLE, NONLINEAR SPINOR FIELD WITH POSITIVE REST ENERGY. Soler, Mario (Junta de Energia Nuclear, Madrid). Phys. Rev., D; 1: 2766-9(15 May 1970).

The influence of nonlinear (fourth-order) terms in the Lagrangians of some classical relativistic field theories is investigated, independently of the mass and coupling-constant parameters. In the spinor case, stable localized configurations with a lowest energy state are shown to exist always for positive values of the coupling constant. (auth)

Quantum Field Theory

Refer also to abstracts 37194, 37677, 37678, 37684, 37705, 37828, 37931, and 37941.

37859 (AD-694545) HEURISTICS OF ELECTRODYNAMIC QUANTUM THEORY. Technical Progress Report No. 2, July 1–

October 31, 1969. Hestenes, David (Arizona State Univ., Tempe. Dept. of Physics). Aug 1969. Contract N00014-68-A-0306. 47p. CFSTI.

A new, physical interpretation of de Broglie waves is suggested. It is assumed that every elementary charged particle is the source, not only of a coulomb field, but also of a monochromatic radiation field with frequency determined by the de Broglie relation. On the basis of this single assumption, and with appeal only to general properties of electromagnetic fields, qualitative explanations are given for all the main features of quantum theory. (auth) (USGRDR)

37860 (NYO-3829-53) SPACE-TIME STRUCTURE AND MEASUREMENT THEORY. Antoine, J.-P. (Pittsburgh Univ., Pa. Dept. of Physics); Gleit, Alan (Carnegie-Mellon Univ., Pittsburgh, Pa. Dept. of Mathematics). Jun 1970. Contract AT(30-1)-3829. 24p. Dep. CFSTI.

A naive operational approach to measurement theory in a truly relativistic framework is given. Both experiments and states exist in finite regions of space-time. The causality structure of the underlying Minkowski space is described in terms of these. (auth)

37861 (RLO-1388-576) NON-EXISTENCE OF SCHWINGER TERMS IN SPINOR QUANTUM ELECTRODYNAMICS. Boulware, David G.; Herbert, Jack (Washington Univ., Seattle. Dept. of Physics). [1970]. 24p. Dep. CFSTI.

The equal time commutator between the space and time components of the electromagnetic current in spinor electrodynamics is calculated, to order α, using the technique of Johnson, Low, and Bjorken; it is found to be a c number. An argument is presented which indicates that the commutator is a c number in all orders of perturbation theory. (auth)

37862 DESCRIPTION OF SPIN AND STATISTICS IN NON-RELATIVISTIC QUANTUM THEORIES BASED ON LOCAL CURRENTS. Grodnik, J.; Sharp, D. H. (Univ. of Pennsylvania, Philadelphia). Contract AT(30-1)-2171. Phys. Rev., D; 1: 1546-59(15 Mar 1970).

The investigation of a previous paper is continued into the irreducible representations of local non-relativistic current algebras. Here, emphasis is given to the new features which arise in classifying the representations of the current algebra with regard to particle statistics, and in including internal variables such as spin. (auth)

37863 PSEUDO-ISOTROPIC SURFACES IN A MINKOWSKI SPACE-TIME. Rosca, Radu (Bucharest Univ.). Compt. Rend., Ser. A; 270: 1071-3(20 Apr 1970). (In French).

Pseudo-isotropic surfaces $V^2_{p.i.}$ are defined in a Minkowski space-time M4 and their existence is established. A $V^2_{p.i.}$ is used as basis for a normal sub-fiber which is a reducible V^3 I-isotrope and a normal fiber V^4 which is a locally flat universe. Some properties of the isotropic congruences of V^4 are formulated. (France)

37864 NON-LORENTZIAN FORM OF THE RELATIVISTIC INVARIANCE PRINCIPLE. Yudin, V. V.; Ershov, A. D. (Far-Eastern State Univ., Vladivostok, USSR). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 4, 121-7(1969). (In Russian).

A linear quasistatistical semigroup realization of a hyperbolic tangent is given, which acts in dual spaces of time and is a relativistic semigroup of endomorphisms. Certain of its properties are cited, and the relation with the Lorentz group is discussed. Introducing semigroup transformations allows an approximation to the space-time concepts and consideration of the concepts of quasistatistical semigroup relativistic endomorphisms and related invariants. (tr-auth)

37865 REPRESENTATIONS OF LOCAL NONRELATIVISTIC CURRENT ALGEBRAS. Grodnik, J.; Sharp, D. H. (Univ. of Pennsylvania, Philadelphia). Contract AT(30-1)-2171. Phys. Rev., D; 1: 1531-45(15 Mar 1970).

It is shown how to specify the particle content of a nonrelativistic quantum theory of N identical spinless particles in terms of observables like the particle number density and the flux density of particles. The approach to this problem is through a study of the irreducible representations of the local, equal-time current algebra, and that the Hamiltonian can be written in terms of the currents in a nonsingular fashion in any irreducible representation. (auth)

37866 SUGAWARA MODEL AND GOLDSTONE BOSONS. Freundlich, Y.; Lurie, D. (Technion-Israel Inst. of Tech., Haifa). Phys. Rev., D; 1: 1660-2(15 Mar 1970).

It is found that SU(2) [and consequently SU(2) × SU(2)] Sugawara current theories are completely equivalent to canonical Lagrangian field theories of massless scalar fields. A Sugawara current theory is obtained by eliminating all the massive fields in a theory of spontaneous symmetry breakdown and retaining the Goldstone bosons only. The reverse is also true in that all Abelian or SU(2) Sugawara theories are necessarily equivalent to these canonical representations, so that for these groups "Sugawara physics" reduces simply to "Goldstone boson physics." (auth)

37867 INFINITELY RISING REGGE TRAJECTORIES AND UNITARITY. Venturi, Giovanni (Rutherford High Energy Lab., Chilton, Eng.). Phys. Rev., D; 1: 1717-19(15 Mar 1970).

The unitarity condition is combined with the assumption of infinitely rising Regge trajectories to obtain constraints on the coupling of the Pomeranchuk singularity to different Regge recurrences of particles which can be produced by diffraction dissociation. The results obtained indicate the possibility that the Pomeranchuk singularity "bootstraps" itself. (auth)

37868 SPIN-DENSITY MATRIX ELEMENTS AND REGGE CUTS. Thews, Robert L. (Univ. of Rochester, N. Y.). Phys. Rev., D; 1: 1847-8(15 Mar 1970).

Relations between spin-density matrix elements valid in reactions dominated by single Regge-pole exchange are reexamined in the presence of Regge cuts. (auth)

37869 EXACTLY SOLUBLE MODEL OF RELATIVISTIC FIELD THEORY. Bialynicki-Birula, I. (Univ. of Pittsburgh). Contract AT(30-1)-3829. Phys. Rev., D; 1: 2347-9(15 Apr 1970).

An exactly soluble model of relativistically invariant and local quantum field theory is described. It satisfies all the usual postulates except the requirement of the positive definiteness of either the energy or the metric in the space of state vectors. The operator is nontrivial and is given explicitly. The two-particle scattering amplitude is calculated. Various generalizations of the model are possible. (auth)

37870 COVARIANT ENERGY DENSITY IN FREE MASSLESS FIELD THEORY. Bender, Carl M. (Inst. for Advanced Study, Princeton, N. J.); Griffiths, David J. Phys. Rev., D; 1: 2335-46(15 Apr 1970).

A covariant stress tensor was discovered for free massless field theories of integer spin. This tensor is constructed and explicitly given. Until now, no covariant stress tensor was known in such theories except for the anomalous cases of spins 0 and 1. It is shown that for massless field theories of spin greater than 1, no ordinary second-rank stress tensor can even exist. It is thus significant that the stress tensor belongs to an infinite-dimensional representation of the homogeneous Lorentz group. This infinite-component stress tensor has remarkable properties which are studied in detail. (auth)

37871 REMARKS ON THE LEE-ZUMINO SUMMATION METHOD. Fels, Stephen (Univ. of California, Los Angeles). Phys. Rev., D; 1: 2370-7(15 Apr 1970).

A method proposed recently by Lee and Zumino for calculating higher-order corrections to the S matrix in nonpolynomial field theories is investigated. When applied to a perturbed harmonic oscillator, grave difficulties are encountered. The reason is found to lie not in the specific summation method, but in the behavior of the perturbing potential at infinity. In the more realistic field-theoretical case, it is shown that perturbation theory gives anomalous values for the vacuum self-energy and the wave-function renormalization constant under certain circumstances. (auth)

37872 TWO-PARTICLE FORCES FOR RELATIVISTIC NEWTONIAN EQUATIONS OF MOTION. Wray, J. G. (Univ. of Pittsburgh). Contract AT(30-1)-3829. Phys. Rev., D; 1: 2212-18 (15 Apr 1970).

Forces are found that satisfy the covariance condition of Currie and Hill for Newtonian equations of motion of two particles in four-dimensional space-time. Examples are given that can decrease, at any prescribed rate, for large particle separation. Unfortunately these latter forces become complex and even singular for certain regions of velocity space. The technique used is to simplify the covariance condition by using four-vector variables as much as possible. (auth)

37873 DYNAMICS OF SYSTEMS OF N POINT-LIKE PARTICLES IN SPECIAL RELATIVITY. Bel, Luis (Paris Univ.). Ann. Inst. Henri Poincare, Sect. A; 12: 307-21(1970). (In French).

Systems of differential equations of the following type are considered: $(dv^i_a/dt) = \mu^i_a(x^j_b, v^j_c)$, $(dx^i_a/dt) = v^i_a(i, j, k = 1, 2, 3; a, b, c = 1, 2, \ldots, N)$. A precise definition of Poincaré invariant systems is given and the necessary and sufficient conditions that the functions μ^i_a of invariant systems must satisfy are derived. Then systems of N point-like particles whose motion can be obtained by integrating an invariant system are considered. The problem of obtaining the total energy-momentum, the total angular momentum and the center-of-mass formula is approached. When N = 2, a new formu-

lation of the necessary and sufficient conditions which ensure the existence of invariant systems is derived. (auth) (France)

37874 QUANTUM FIELD THEORY. VOLUME 1. Visconti, A. International Series of Monographs in Natural Philosophy. Volume 23. New York; Pergamon Press Inc. (1969). 310p.

Translated by H. Bacry and C. M. Hancock.

Volume I deals with general principles; the quantum pictures; fundamental field observables; linear wave equations and invariants of the first order; quantization of linear field equations with constant coefficients; and quantization of linear field equations with constant coefficients. (L.B.S.)

37875 EQUIVALENCE BETWEEN TWO THEORIES OF ELEMENTARY AND COMPOSITE PARTICLES FOR A SEMIRELATIVISTIC FIELD. Said, Tanios (Paris Univ.). Compt. Rend., Ser. A; 270: 1385-8(25 May 1970). (In French).

The equivalence conditions between two theories of elementary and composite particles for a semi-relativistic model of bosons is studied. In the limit case ($g_1^2 \to \infty \to Z \to 0$) the equivalence entails a certain acceleration of $Z \to 0$. (auth) (France)

37876 REGGE TRAJECTORIES IN THE WICK-CUTKOSKY MODEL: THE REPULSIVE CASE. Murai, N. (Tokyo Univ.). Lett. Nuovo Cim.; 4: 65-70(11 Jul 1970).

The Regge trajectories $l(\eta^2)$ in the Wick-Cutkosky model ($4\eta^2$ is the center-of-mass energy squared) are examined in the first order in the coupling constant λ in the repulsive case ($\lambda < 0$). The results show that the leading trajectory with an even time parity behaves differently from the corresponding nonrelativistic case, and they exhibit new behaviors that are not found in the attractive case. It is also shown that the trajectories in the repulsive case have the same asymptotic behavior as in attractive case except for the two leading trajectories with an even time parity. (L.B.S.)

37877 TIME-SYMMETRIC INTERACTIONS AND QUANTUM ELECTRODYNAMICS. Krizan, John E. (Univ. of Rochester, N. Y.). Phys. Rev., D; 1: 2772-4(15 May 1970).

The derivation of an action form from a time-symmetric formalism for quantum electrodynamics is given. A constraint added to a Fokker-type functional leads directly to an expression given recently by Schwinger; however, no supplementary renormalization condition is required here. (auth)

37878 INFINITE-MOMENTUM LIMIT OF A SPINOR FIELD THEORY. II. Flory, David (Fairleigh Dickinson Univ., Teaneck, N. J.). Phys. Rev., D; 1: 2795-2807(15 May 1970).

A self-contained theory of Dirac fermions interacting with (pseudo-) scalar bosons at infinite momentum was constructed. The fields are coupled with a $\bar{\psi}\Gamma\psi\phi$ interaction where $\Gamma = 1$ or γ^5, depending on the parity of the boson. The theory is designed to give the correct relativistic dynamics when the space of intermediate states is restricted to those states which can be interpreted as the infinite-momentum limit of sets of particles with finite momentum, that is, those states which correspond to the particle configurations observed in nature. The intermediate states which were eliminated are those containing particles moving away from the infinite-momentum observer. The dynamical effect of these states is incorporated into a counterterm in the Hamiltonian. The effect of this counterterm is to produce a set of four-point vertices in the old-fashioned Hamiltonian perturbation expansion. The perturbation-theory rules for this model are described in an earlier paper. A general formalism for handling interactions at infinite momentum is presented here. It is used to derive the counterterm for our model theory. A complete set of generators for the Poincaré group in a basis appropriate to the infinite-momentum limit is demonstrated. These generators satisfy the commutation algebra of the Poincaré group, proving the relativistic invariance of the theory and its internal consistency. (auth)

37879 EIKONALS AND WU-YANG CONJECTURE IN QUANTUM ELECTRODYNAMICS. Yao, York-peng (Univ. of Michigan, Ann Arbor). Phys. Rev., D; 1: 2971-3(15 May 1970).

In the absence of vacuum polarization and under generalized soft-exchanged-photon approximations, the leading behavior of charged-particle-scattering amplitudes proportional to the square of the electromagnetic form factors, as conjectured by Wu and Yang, multiplied by the eikonal functions. This result includes radiative correction to all orders. It is further pointed out that it remains true in the presence of neutral scalars and pseudoscalars under the same approximation. (auth)

37880 NONWEAK-COUPLING REGGE TRAJECTORIES FROM FIELD-THEORY MODELS. Swift, Arthur R.; Tucker, Robin W. (Univ. of Massachusetts, Amherst). Phys. Rev., D; 1: 2894-2900(15 May 1970).

Perturbation-theory techniques are used to generate an approximate transcendental equation for the leading Regge pole produced by an infinite sum of Feynman ladder diagrams. This equation is not restricted to the weak-coupling domain and can be used to produce trajectories with $\alpha(0) > 0$. The equation is solved both below and above the elastic and inelastic thresholds to provide the first complete description of a relativistic Regge trajectory in the ladder-diagram model. The same technique is used to generate potential-theory trajectories which agree with the exact solutions obtained by more complicated methods. (auth)

37881 GAUGE-INDEPENDENT FORMULATION OF A MASSIVE FIELD WITH SPIN ONE. Takahashi, Yasushi; Palmer, Roger (Univ. of Alberta, Edmonton). Phys. Rev., D; 1: 2974-6 (15 May 1970).

A divergenceless skew-symmetric second-order tensor field with a finite mass is considered. A Lagrangian is constructed. The quantization is performed for the free field, the propagator is obtained, and the relationship to the Proca field is discussed. (auth)

37882 BROKEN CHIRAL SYMMETRY AND THE TRANSFORMATION PROPERTIES OF ASYMPTOTIC FIELDS. Soln, Josip (Univ. of Wisconsin, Milwaukee). Phys. Rev., D; 1: 2882-4 (15 May 1970).

The chiral transformation of asymptotic fields in the presence of symmetry breaking is discussed in a model of interaction between a quantized Dirac field and an external electromagnetic field. It is concluded from this model that the asymptotic fields will generally transform nonlocally and nonlinearly. Only if the symmetry breaking is small, or if the interaction is sufficiently weak, will the asymptotic fields transform locally and linearly as a first approximation. (auth)

37883 GAUGE INVARIANCE AND DYNAMICAL SYMMETRY BREAKING. Parisi, G.; Testa, M. (Univ., Rome). Contract f 61-05267-C-0084. Lett. Nuovo Cim.; 4: 71-2(11 Jul 1970).

It has been shown that in the Lorentz gauge formulation of quantum electrodynamics, the Goldstone boson becomes an unphysical state of negative norm. A general nonperturbative argument is given that supports the conclusion that either the Goldstone boson is unphysical or the symmetry is not broken. (L.B.S.)

37884 INFINITE-COMPONENT LOCAL FIELD THEORY WITH A RISING MASS SPECTRUM. Chodos, Alan (Cornell Univ., Ithaca, N. Y.). Phys. Rev., D; 1: 2937-44(15 May 1970).

An infinite-component field theory is proposed to describe the ρ Regge family of particles. Using the generators of the group O(3, 2), a class of first-order wave equations is obtained. The simplest of this class of equations is solved to yield a rising mass spectrum with a hydrogenlike accumulation point. Because only finite-dimensional representations of the homogeneous Lorentz group appear in the theory, it is free from many of the difficulties, including noncausality, which have plagued other infinite-component field theories with nontrivial mass spectra. (auth)

37885 GENERAL FERMION REGGEIZATION WITHOUT PARITY DOUBLING. Klein, S. A. (Claremont Coll., Calif.). Phys. Rev., D; 1: 2968-9(15 May 1970).

The Reggeization scheme of Carlitz and Kislinger is extended to daughter trajectories. (auth)

37886 QUANTUM ELECTRODYNAMICS IN THE INFINITE-MOMENTUM FRAME. Kogut, John B.; Soper, Davison E. (Stanford Univ., Calif.). Phys. Rev., D; 1: 2901-14(15 May 1970).

The formal foundations of quantum electrodynamics is examined in the infinite-momentum frame. The infinite-momentum limit is interpreted as the change of variables $\tau = 2^{-1/1}(t + z)$, $Z = 2^{-1/1}(t - z)$, thus avoiding limiting procedures. Starting from the Feynman rules, a τ-ordered perturbation expansion is derived from the S matrix. It is then shown how this expansion arises from a canonical formulation of the field theory in the infinite-momentum frame. It is conjectured that this approach should lead to convenient approximation schemes for electrodynamics at high energy. (auth)

37887 GUAGE-INVARIANCE OF THE SECOND KIND AND CURRENT AND FIELD COMMUTATION RULES. Lopes, J. Leite (Carnegie-Mellon Univ., Pittsburgh). Nuovo Cim.; 68A: 301-16 (21 Jul 1970).

A conserved and relativistically invariant operator is postulated to induce gauge transformations of the second kind of charged fields and massless vector fields in mutual interaction. Commutation rules between the charged field and current and between vector field variables on a spacelike surface follow from the action of this unitary operation on the fields. The electromagnetic and the Yang–Mills isospin gauge transformations are studied. (auth)

37888 THE k-SPACE METHOD FOR THE ASYMPTOTIC BEHAVIOUR OF FEYNMAN INTEGRALS. Negrine, S. M. (Univ. of Cambridge, Eng.). Nuovo Cim.; 68A: 165-83(21 Jul 1970).

A new method is developed for the evaluation of the leading high-energy behavior of Feynman integrals in scalar φ^3 and $\varphi^3 + \varphi^4$ field theory models for elastic scattering. This method is based on the observation that such leading behavior must come from the singularity of each Feynman integral at infinite energy, this singularity arising from a pinch of the loop-momentum contours of integration by the poles of the integrand when the energy becomes infinite. The leading behavior comes by integrating over the pinch regions. An advantage is that the integrations are performed directly in loop-momentum k-space, and without any ad hoc assumptions about the dominant region of integration. In particular Gribov's assumption of finite masses on Feynman propagators is discussed in the framework of perturbation theory. Other advantages include avoiding some renormalization difficulties and technical ease in treating Feynman diagrams with 4-point vertices as simply as those with 3-point vertices. Examples are given to illustrate the essential features of the method. (auth)

37889 GAUGE INVARIANCE AND REGULARIZATION. Medvedev, B. V.; Pavlov, V. P.; Sukhanov, A. D. (Mathematics Inst., Moscow). Zh. Eksp. Teor. Fiz.; 58: 2099-2109(Jun 1970). (In Russian).

It is shown that Pauli–Willars regularization required for conservation of gauge invariance at all calculation stages in perturbation theory possesses some singular properties. Thus integrals of positively definite functions, converging as well as diverging, are made to vanish; moreover it leads to discontinuities in the regular parts of diverging diagrams. The physical meaning of the Pauli–Willars procedure is discussed, and the possibility of extending the procedure in such a way as to make the diverging parts of all diagrams vanish is discussed. (auth)

37890 BEHAVIOR OF COMMUTATOR MATRIX ELEMENTS AT SMALL DISTANCES. I. EXISTENCE AND STRUCTURE OF EQUAL-TIME LIMITS. Voelkel, A. H. (Univ., Nijmegen, Netherlands. Univ. of Pittsburgh). Contract AT(30-1)-3829. Phys. Rev., D; 1: 3377-85(15 Jun 1970).

The behavior of commutator matrix elements at small distances is investigated in the framework of general quantum field theory. The equivalence between current density commutators and the commutators of a finite number of charge moments and a current density at equal times is proved by means of microcausality but without using the spectrum condition. If N is the (finite) order of the commutator, then the equal-time limits of the commutators between all charge moments of degree higher than $2N + m - 1$ (m fixed between zero and N) and a current density vanish. The equal-time commutators between the first $2N + m - 1$ charge moments and a current density exist if and only if the equal-time limit of the corresponding current densities exists and is a sum of $2N + m - 1$ derivatives of the δ function in the space variables x. The coefficients of the individual δ functions are identical to the equal-time limits of the charge moments and one density. If the spectrum condition holds in addition, then m is equal to zero. (auth)

37891 POINT-SOURCE LIMIT OF A MODEL FIELD THEORY AND THE QUESTION OF COMPOSITENESS. Freeman, David F.; Rubin, Morton H. (Univ. of Pennsylvania, Philadelphia). Contract NSF-GP-8414. Phys. Rev., D; 1: 3386-91(15 Jun 1970).

The point-source limit is found for a previously proposed static model satisfying crossing symmetry and two-particle unitarity below three-particle thresholds. A numerical solution for this limit is obtained, and both renormalized and unrenormalized quantities are calculated. The renormalization constants are found to vanish; the relation of this to compositeness of the neutron in this model is discussed. (auth)

37892 RELATIVISTIC QUANTUM MECHANICS OF TWO INTERACTING PARTICLES. Fronsdal, C.; Lundberg, L. E. (International Centre for Theoretical Physics, Trieste, Italy). Phys. Rev., D; 1: 3247-58(15 Jun 1970).

A variation of the quasipotential approach of Logunov and Tavkhelidze is investigated. Two relativistic particles with or without spin are subjected to a mutual interaction that can be described (i) as generated by the exchange of field quanta or (ii) as a two-particle potential V(r) that depends on the relativistic three-dimensional coordinates introduced by Kadyshevsky. The framework includes the complete axiomatic structure of nonrelativistic quantum mechanics (except that the metric in Hilbert space is indefinite in the same way as in the static Klein–Gordon or Dirac theories) and is at the same time fully and explicitly covariant. Both the nonrelativistic and the classical limits exist and are susceptible to detailed interpretation. The case of two spinless particles with a "relativistic Coulomb" interaction is examined in detail. The wave equation, as well as the equation for the T matrix, is in this case exactly soluble. Closed analytic expressions are given for transition form factors, including "photoproduction," the elastic scattering amplitude, and a production amplitude (bremsstrahlung). (auth)

37893 SUGAWARA MODEL, BROKEN SYMMETRIES, AND MASSLESS-BOSON FIELDS. Freundlich, Y. (Technion–Israel Inst. of Tech., Haifa, Israel). Phys. Rev., D; 1: 3290-6(15 Jun 1970).

It is asserted that the Sugawara theory of currents is equivalent to a canonical Lagrangian theory of massless scalar fields with a Yang-Mills type of interaction. The Sugawara currents are identified with the canonical currents associated with nonlinear transformations of the massless fields. These transformations arise naturally in the context of spontaneous symmetry breakdown. In models of spontaneously broken symmetry in which the symmetry-breaking scalar fields are elementary dynamical variables, that part of the stress-energy tensor containing the Goldstone bosons terms goes over into the Sugawara form when reexpressed in terms of the currents. However, additional terms relating to a massive field appear in the stress-energy tensor, and the massive field operator replaces the usual Sugawara constant. A Sugawara current theory is obtained by eliminating the massive field and retaining the Goldstone boson field only. The reverse is also true in that any Sugawara theory is necessarily equivalent to this canonical representation. Finally, it is shown that if the currents are coupled to gauge fields, a massive Yang-Mills field is obtained. (auth)

37894 MOMENTUM-SPACE BEHAVIOR OF INTEGRALS IN NONPOLYNOMIAL LAGRANGIAN THEORIES. Salam, Abdus; Strathdee, J. (International Centre for Theoretical Physics, Trieste, Italy). Phys. Rev., D; 1: 3296-3312(15 Jun 1970).

Methods are developed for constructing momentum-space amplitudes corresponding to nonpolynomial nonderivative interactions of a real scalar field. The methods give rise to a supergraph technique and rules for writing down matrix elements very similar to Feynman techniques. The methods are not established rigorously; at several points the argument requires certain analytic properties of Feynman integrands which, though plausible, can only be demonstrated rigorously for the zero-mass case. Asymptotic behavior, both in spacelike and timelike directions, is discussed. Rough arguments are given that indicate that the singularity structure of the amplitudes is likely to be consistent with unitarity. (auth)

37895 RIGOROUS LOWER BOUND ON THE KAWARABA-YASHI–SUZUKI–RIAZUDDIN–FAYYAZUDDIN RELATION FROM FIELD THEORY: THE STATUS OF FIELD-CURRENT IDENTITY FOR INTERACTING FIELDS. Acharya, R. (Univ., Bern); Narayanaswamy, P.; Santhanam, T. S. Phys. Rev., D; 1: 3403-5 (15 Jun 1970).

The possibility of retaining the axial-vector field-current identity for interacting π and A_1 fields which are dynamically independent in the sense that $[a_\mu, \pi] = 0$ and $[a_\mu, \pi] = 0$ at equal times is shown to lead to an inconsistency unless the mass of the pion is zero. A lower bound on the parameter $G_\rho/(\sqrt{2}m_\rho F_\pi)$ is established for massless pions. (auth)

37896 NONCAUSAL BEHAVIOR OF CLASSICAL TACHYONS. Pirani, F. A. E. (King's Coll., London). Contract F61052-69-C-0012. Phys. Rev., D; 1: 3224-5(15 Jun 1970).

It is shown by example that causality violation can take place through the transmission of classical tachyons between three or more observers in such a way that each observer receives and emits only tachyons whose energies he measures to be positive. Such examples are not open to the ambiguities of interpretation proposed by Feinberg; they imply that a classical-particle description of tachyons is not physically viable. (auth)

37897 FERMION REPRESENTATIONS OF SUGAWARA'S THEORY OF CURRENTS. Rabl, A. (Weizmann Inst. of Science, Rehovot, Israel). Phys. Rev., D; 1: 3437-41(15 Jun 1970).

The work of Coleman, Gross, and Jackiw is continued so that the products of currents occurring in Sugawara's model should be interpreted as a singular limit as the coordinate separations approach zero, if the currents are the usual $\bar{\psi}\,\frac{1}{2}\lambda^a\gamma_\mu\psi$. They found that $\theta_{\mu\nu}$ of the free-fermion theory can be expressed in the Sugawara form. It is pointed out that their method works even in the presence of interactions; consequently, Sugawara's energy-momentum tensor can only describe the massless free part of any fermion theory. This can also be seen from the fact that Sugawara's equations of motion for fermion currents are equivalent to $\gamma \cdot \partial\psi = 0$. It is suggested that the most natural interaction term to be added to Sugawara's $\theta_{\mu\nu}$ is the fully normal-ordered

$\frac{1}{2}F : V_\lambda^2 V^{\alpha\lambda}$: occurring in Heisenberg's nonlinear spinor theory. The resulting equations of motion for the currents still have the Sugawara form (with an additional normal-ordered term). Finally, an attempt is made to derive the commutators of $\theta_{\mu\nu}$ with itself and with the currents, using current algebra without any reference to the underlying fields. Here it is not known how to handle time-like separations, and with spacelike separations alone we do not find a consistent solution. (auth)

37898 DEGENERACY OF THE MASS SPECTRUM FOR INFINITE-COMPONENT FIELDS. Oksak, A. I. (Inst. for High-Energy Physics, Serpukhov, USSR); Todorov, I. T. Phys. Rev., D; 1: 3511-13(15 Jun 1970).

The "no-go" theorem of Grodsky and Streater is extended to nonrenormalizable local theories in which the two-point function may increase faster than any polynomial in momentum space. As a result the nonexistence of a local irreducible infinite-component field with a nontrivial mass spectrum is demonstrated without "technical" assumptions. (auth)

Gravitation and General Relativity

Refer also to abstracts 37165 and 37568.

37899 (NYO-2262-TA-218) THE THEORY OF GENERAL RELATIVITY. Westervelt, Peter J. (Brown Univ., Providence, R. I.). 1970. 61p. Dep. CFSTI.

The discussion covers a review of special relativity and the linearized theory of general relativity including linearized equations of motion, the energy-momentum pseudotensor, experimental predictions, general relativistic definition of the center of mass, locally plane gravitational waves, and the sources of gravitational waves. Also included are gravitational radiation, the oscillating neutron star, gravitational radiation from a pulse of light, cosmology, gravitational radiation from a laser, and from a finite pulse. Some exact results from general relativity are also given. (J.F.P.)

37900 RELATIVISTIC GRAVITATIONAL BREMSSTRAHLUNG. Peters, P. C. (Univ. of Washington, Seattle). Phys. Rev., D; 1: 1559-71(15 Mar 1970).

Gravitational radiation is calculated for the situation of a small mass passing a large mass in an unbound trajectory, where the velocity of the small mass can be relativistic. This allows gravitational radiation to be studied for cases in which the slow-motion approximation is not valid. The gravitational potentials, or perturbations in the metric, arising from the small mass, are determined explicitly by solving the perturbed field equations of general relativity, which are obtained by expanding the metric about a metric representing the geometry of the large mass. From these the energy flux of the emitted waves is calculated. In the nonrelativistic limit, the results agree with those of the slow-motion approximation. The qualitative behavior of the radiation at extreme relativistic velocities is discussed, and is found to disagree with what one would expect from the fast-motion approximation in that same limit. Numerical results are presented for the total energy, power, and angular distribution of energy radiated for a range of velocities from 0.01c to 0.9999c. Significant features in the extreme relativistic limit are the peaking of the radiation in the forward direction and the peaking also in time, which both occur in electromagnetic radiation, and the fact that the total energy radiated in one transit is proportional to $(1 - v^2/c^2)^{-\frac{1}{2}}$. (auth)

37901 SPHERICALLY SYMMETRIC SOLUTION IN THE ALREADY UNIFIED FIELD THEORY: THE REGULAR CASE OF BORN-INFELD ELECTROMAGNETISM. Poletti, Pierre (Inst. Henri Poincare, Paris). Compt. Rend., Ser. A; 270: 1067-70(20 Apr 1970). (In French).

The spherically symmetric static solution of the Rainich problem is shown to describe a physical state including Born–Infeld gravitation and electrostatics. The metric is identified with the Born metric in the same case. (France)

37902 ERRORS IN THE APPROXIMATION EQUATIONS FOR THE MOTION OF BODIES IN THE GENERAL THEORY OF RELATIVITY. Ryabushko, A. P. (Belorussian State Univ., Minsk). Vestsi Akad. Navuk BSSR, Ser. Fiz.-Mat. Navuk; No. 2, 86-95(1970). (In Russian).

No proof has been presented as yet for the convergence of the approximation method used in the general theory of relativity for solving Einstein's equations of gravitation and for deriving the equations of motion of bodies; only the agreement between theoretical predictions and experimental data could be indicated, as for instance, in the case of the perihelion of Mercury. This is considered insufficient from the mathematical point of view. Estimates were made concerning the magnitude of the errors due to the use of equations derived from experimental bodies instead of Newtonian and post-Newtonian equations in a Schwarzschild field, indicating areas in which the approximation theory of motion may yield results close to the exact values and identifying the range within which the errors become very large. The curvature of space and changes in the course of the time were taken thereby into account. The true radius of the Schwarzschild sphere was also calculated. The examined secular effects must be considered when a body with finite dimension instead of a point-shaped one is being studied. (TTT)

37903 INTEGRAL CONSERVATION LAWS IN THE GENERAL THEORY OF RELATIVITY. Konopleva, N. P. Dokl. Akad. Nauk SSSR; 190: 1070-3(11 Feb 1970).

It is shown that the integral laws of the conservation of angular "momentum," "energy," and "momentum" of a system of bodies in a deformed V_4 may be derived from one covariant differential conservation law of the symmetric energy-momentum tensor of the system; it is thereby assumed that the space-time of V_4 allows some group of motion. The impulse and the momentum refer to values, the coordinates of which are similar to the corresponding values in Cartesian coordinates in plane V_4. This designation is somewhat restricted in the Riemann space. The expressions derived for the integral conservation laws are characterized by time invariance; in the examined case the time lines are orthogonal with respect to the space-time section of $X^0 = \text{Const}$. The Zel'manovich type of time invariance ensures that the values found are independent of arbitrary transformations of the coordinates, related to a given readout system. (TTT)

37904 SPATIALLY HOMOGENEOUS GRAVITATIONAL FIELDS. Grishchuk, L. P. Dokl. Akad. Nauk SSSR; 190: 1066-9(11 Feb 1970). (In Russian).

The spatially homogeneous metric is defined as one which allows a simple or multiple transitive group of motion (C_r, $r \geq 3$) which acts on space-like hypersurfaces. This definition, although repeatedly mentioned, is not always justified from the physical point of view. The case $r = 3$ is examined. A semigeodetic (synchronous) coordinate system was chosen as one which fulfills a specific condition of transitive hypersurfaces. It was attempted to derive Einstein's equation for all types of metrics. (TTT)

37905 SYMMETRY PROPERTIES AND CONSERVATION LAWS IN SCALAR-TENSOR THEORIES OF GRAVITATION. Hart, Harold Bird. Provo, Utah; Bringham Young Univ. (1969). 134p.

Thesis.

A review of methods of deriving conservation laws for physical systems is carried out with particular emphasis on the symmetry method. Previous applications of conservation laws to classical and relativistic theories, especially Einstein's generally invariant theory of gravitation, are summarized. The above methods are then applied to the scalar-tensor theories of gravitation and generalizations of the Einstein pseudotensor, the Freud and Møller superpotentials, and the Komar generator are derived. Two possible forms of the scalar-tensor Komar generator are discussed and application of these generators to the scalar-tensor Schwarzschild field yields two different results for the total energy both of which have been obtained previously by other methods. The symmetry properties of scalar-tensor theories are examined and a restriction on Killing's equations is found which seems to have a physical significance. (Diss. Abstr. Int., B)

37906 PLANE WAVES IN GENERAL RELATIVITY THEORY. Rodichev, V. I.; Dozmorov, I. M. Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 4, 20-3(1969). (In Russian).

Using the method of Newman–Penrose a class of gravitational fields in empty space is studied permitting the normal congruence of isotropic geodesics. With the energy–momentum tensor in tetrad form it is shown that if the nondegenerate metrics of such fields depends only on one isotropic coordinate, then the solutions describe plane gravitational waves. (tr-auth)

37907 FIELD CREATED BY A POINT CHARGE IN THE GENERAL RELATIVITY THEORY. CLASSICAL EIGENENERGY. Chevreton, Michel. Compt. Rend., Ser. A; 270: 989-92(13 Apr 1970). (In French).

The generalized solution of the Einstein–Maxwell equations for a unipolar electric point charge is given. The electromagnetic and gravitation eigenenergy calculated is found to be finite. (France)

37908 EINSTEIN SPACE OF N TYPE WITH NONINTEGRABLE RADII. Leroy, Jules (Brussels Univ.). Compt. Rend., Ser. A; 270: 1078-80(20 Apr 1970). (In French).

The metric of a four-dimensional Einstein space of 2 signature whose Weyl tensor is of N type in the Petrov classification is pre-

sented. The (quadruple) eigenvector of the Weyl's tensor is not integrable. The space allows a group of three-parameter isometrics acting transitively on sub-varieties of time kind. (France)

37909 NEW PROPERTIES OF THE HAMILTON–JACOBI FUNCTIONAL FOR GENERAL RELATIVITY. Komar, Arthur (Yeshiva Univ., New York). Phys. Rev., D; 1: 1521-3(15 Mar 1970).

It is shown that, analogously to the situation in the usual classical theories, the solution of the Hamilton–Jacobi equations of general relativity, S, satisfies the relation $S = \int L d^4x$, where, however, L is the Lagrangian density of Dirac, rather than the more usual Einstein Lagrangian. This result is then used to prove that if $S = \int S(g_{mn})d^3x$, the integrand S is a three-dimensional scalar density which is a homogeneous functional of g_{mn} of degree 1. (auth)

37910 RELATIVISTIC SYSTEMS OF PARTICLES IN GRAVITATIONAL INTERACTION. Levy-Leblond, Jean-Marc (Faculte des Sciences, Paris). Phys. Rev., D; 1: 1837-40(15 Mar 1970).

An elementary heuristic discussion of relativistic systems of particles in mutual gravitational interaction is given. Both in the boson and fermion cases, the main features of rigorous treatments are very simply recovered. A conceptual dilemma touching the use of various coordinate systems in such consideration is clarified. Finally, it is shown that in any realistic boson system, the relativistic effects of gravitation are probably masked by the other fundamental interactions, in contradistinction with fermion systems. (auth)

37911 CHARACTERISTIC CLASSES AND WEYL TENSOR: APPLICATIONS TO GENERAL RELATIVITY. Avez, Andre (Univ. of California, Berkeley). Contract AT(11-1)-36. Proc. Nat. Acad. Sci. U. S.; 66: 265-8(Jun 1970).

Chern and Simons proved that the Pontrjagin forms of a Riemannian manifold remain invariant under a conformal deformation. It is shown that these forms can be expressed uniquely in terms of the conformal curvature tensor: this provides a new proof of their result. Similar techniques can be applied to Euler–Poincare characteristic class, as suggested by A. Taub. The following is obtained: If the Weyl tensor of a compact space time is of type III of Bel–Petrov, then it cannot carry a perfect fluid + electromagnetic field. (auth)

37912 PARADOX IN INTERACTION OF THE GRAVITATIONAL AND ELECTROMAGNETIC FIELDS. Woodward, James F.; Youngran, Wolfgang (Univ. of Denver). Nature (London); 226: 619-21(16 May 1970).

To account for the anomalous results obtained from experiments designed to test some consequences of the general theory of relativity three assumptions are made. The main assumption is that the extent of the interaction of the electromagnetic field with the gravitational field is dependent on the frequency of the electromagnetic field, which is inconsistent with the general theory of relativity. The results of several experiments are discussed in relation to the assumptions. (UK)

37913 ELECTRODYNAMICS IN GENERAL THEORY OF RELATIVITY. II. PROPERTIES OF ASYMPTOTICALLY PLANE SPACES WITH ELECTROMAGNETIC RADIATION. Dozmorov, I. M. Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 3, 7-14(1970). (In Russian).

A Newman–Penrose method was used for determining the behavior of space with limited sources and electromagnetic and gravitational radiation. An expansion of Veil and Maxwell metrics and tensors was obtained by the inverse degree of the distance from the source systems. A complete energy was formulated for a system including the energy of gravitational and electric fields. (R.V.J.)

37914 GROUP OF MOTIONS OF SPACES OF THE ROBERTSON–WALKER TYPE. Navez, J. (Institut de Mathematique, Liege). Bull. Soc. Roy. Sci. Liege; 38: 629-38(1969). (In French).

The study of intrinsic properties of four-dimensional riemannian spaces leads one to consider the infinitesimal group of motions of those manifolds. The Robertson-Walker's metric often used in general relativity is dealt with. It is found that Robertson-Walker's spaces have always a six-parameters group except when their curvature is constant where they have, of course, a ten-parameters group. (auth)

37915 GRAVITATIONAL RADIATION FROM A BOUNDED SOURCE. I. Madore, J. (Paris Univ.). Ann. Inst. Henri Poincare, Sect. A; 12: 285-305(1970). (In French).

An obstruction is found to considering a solution of the linearized field equations in harmonic coordinates as a first approximation to a radiative solution of the exact field equations with bounded sources. (auth) (France)

37916 CONTRIBUTION TO THE STUDY OF SPINNING QUASI-SPHERICAL MASSES IN THE GENERAL RELATIVITY THEORY. Teyssandier, Pierre. Ann. Inst. Henri Poincare, Sect. A; 12: 263-83(1970). (In French).

The gravitational field outside and inside a thin spherical shell spinning with a constant angular velocity ω is systematically considered in first and second order of approximation with respect to ω. A method of successive approximations leads one to reconsider the hypothesis made by Brill-Cohen and to modify the results anounced by Thirring, Bach and Bass-Pirani. (auth) (France)

37917 ANISOTROPY AND POLARIZATION IN THE GRAVITATIONAL-RADIATION EXPERIMENTS. Weber, J. (Inst. for Advanced Study, Princeton, N. J.). Phys. Rev. Lett.; 25: 180-4(20 Jul 1970).

Large anisotropy is observed for gravitational-radiation–detector intensity as a function of sidereal time, with peaks in the direction of the galactic center and in the opposite direction consistent with 12-h antenna symmetry. The 12-h sidereal-time histograms exhibit anisotropy exceeding 6 standard deviations from the mean. (auth)

37918 EXTENSIONS OF THE TAUB AND NUT SPACES AND EXTENSIONS OF THEIR TANGENT BUNDLES. Hajicek, Petr (Univ., Bern). Commun. Math. Phys.; 17: 109-26(1970).

A system of extensions of the Taub space and the NUT space with the topology due to Misner is constructed having the property: for each incomplete geodesic in these space-times, there is one and only one extension from the system into which the geodesic smoothly continues. Next, the notion of hypermanifold is introduced which is a generalization of tangent bundle of a space-time, and an untrivial hypermanifold is constructed that contains the tangent bundles of the Taub and NUT spaces as proper submanifolds, and within which almost all geodesics are complete. Locally, the hypermanifolds do not yield anything new, but they provide much broader choice of global properties than any four-dimensional space-time manifold. (auth)

37919 SIMPLIFIED EQUATIONS FOR RELATIVISTIC ROTATING PERFECT FLUIDS WITH AXIAL SYMMETRY. Harrison, B. K. (California Inst. of Tech., Pasadena). Phys. Rev., D; 1: 2269-71(15 Apr 1970).

The general relativistic equations for a stationary axially symmetric rotating perfect fluid, in a comoving coordinate system, are presented in an elegant general form. The coordinates can then be chosen in any of several ways to further simplify the equations. One choice reduces the number of independent metric functions to three. (auth)

37920 STABILITY OF THE SCHWARZSCHILD METRIC. Vishveshwara, C. V. (Univ. of Maryland, College Park. Goddard Space Flight Center, New York). Phys. Rev., D; 1: 2870-9(15 May 1970).

The stability of the Schwarzschild exterior metric against small perturbations is investigated. The perturbations superposed on the Schwarzschild background metric are the same as those given by Regge and Wheeler, consisting of odd- and even-parity classes, and with the time dependence exp (–ikt), where k is the frequency. An analysis of the Einstein field equations computed to first order in the perturbations away from the Schwarzschild background metric shows that when the frequency is made purely imaginary, the solutions that vanish at large values of r, conforming to the requirement of asymptotic flatness, will diverge near the Schwarzschild surface in the Kruskal coordinates. Since the background metric itself is finite at this surface, the above behavior of the perturbation clearly contradicts the basic assumption that the perturbations are small compared to the background metric. Thus perturbations with imaginary frequencies that grow exponentially with time are physically unacceptable, and hence the metric is stable. Perturbations with real values of k representing gravitational waves are also examined. It is shown that the only nontrivial stationary perturbation that can exist is one that is due to the rotation of the source, which is given by the odd perturbation with the angular momentum $l = 1$. The significance of solutions with complex frequencies is pointed out, as is the lack of a theorem (completeness of the eigenfunction) for the even-parity case to parallel the Sturm-Liouville theory, which is applicable to the odd-parity case. Such a theorem would be required to convert the computations indicating stability as given here into a fully rigorous stability theorem. (auth)

37921 BRANS–DICKE THEORY UNDER TRANSFORMATION OF UNITS AND ITS RELATION TO THE JORDAN THEORIES. Morganstern, R. E. (Rice Univ., Houston, Tex.). Phys. Rev., D; 1: 2969-71(15 May 1970).

The relation between the original form of the Brans-Dicke (BD) theory and a particular form of the Jordan theory has been pointed out by Dicke. Here the relation between the various unit-transformed BD theories and other Jordan theories is established. Although this formal identification is possible, the two theories are not equivalent, because of the different interpretations given to the matter Lagrangian and conservation laws in the various forms of the two theories. (auth)

37922 INERTIAL POTENTIALS IN CLASSICAL AND QUANTUM MECHANICS. Papini, G. (Univ. of Saskatchewan, Regina). Nuovo Cim.; 68B: 1-10(11 Jul 1970).

The study of wave equations in accelerated reference frames allows, in principle, a selection among theories of inertia based on the transformation properties of the corresponding potentials. It is shown, in particular, that invariance of the classical equations of motion and of the Schrödinger equation under the same set of transformations leads to Sciama's theory of inertia in the limit $GM/c^2R \sim 1$. Tests which allow distinguishing between this vector theory and general relativity are proposed and briefly discussed. (auth)

37923 STRESS-TENSOR COMMUTATION RELATIONS. Trubatch, J. (Brandeis Univ., Waltham, Mass.). Nuovo Cim.; 68A: 339-67(21 Jul 1970).

The general requirements on the equal-time commutation relations among the components of the stress-energy tensor imposed by the Poincaré relations and the spectral expansion are shown not to hold for free fields of spin zero and one. These difficulties are only partially resolved by spreading the points in the definition of the stress tensor. In the presence of an external gravitational field, covariance relates the stress-tensor commutators and the metric dependence of the stress tensor. The classical metric dependence of the stress tensor is not sufficient to satisfy the general requirements on the stress-tensor commutation relations and various procedures for remedying this are discussed. In the presence of dynamical spin-two fields, spectral arguments imply nonvanishing commutation relations between the stress tensor and the spin-two field variables. The classical metric dependence of the stress-tensor is shown insufficient to satisfy these relations for the linearized gravitational field. (auth)

37924 CONSISTENCY OF WAVE EQUATIONS IN DE-SITTER SPACE. Vidal, A. (Centro Brasileiro de Pesquisas Fisicas, Rio de Janeiro). Notas Fis., Cent. Brasil. Pesqui. Fis.; 16: 1-8(1970).

Spin-1 particles interactions with gravitational or electromagnetic fields are studied when a De Sitter space is considered and the procedure to obtain consistent spinorial equations with interaction is similar to that developed previously. A tensor formulation of those equations is also obtained which is the extension to the De Sitter space of the Proca equations minimally coupled. (J.F.P.)

37925 MACH'S PRINCIPLE AND DIFFERENTIABLE MANIFOLDS. Heller, M. Acta Phys. Pol.; B1: 131-8(Apr-Jun 1970).

A more complete list of different formulations pretending to play the role of the so-called Mach's Principle is given and some theorems about the possibility of their realization are proved. A physical theory using for the geometrization of the gravitation a geometry based on the concept of differential manifold cannot be entirely Machian. (auth)

37926 SOME REMARKS ABOUT TWO TRIALS OF MACH'S PRINCIPLE REALIZATION. Heller, M. Acta Phys. Pol.; B1: 123-30(Apr-Jun 1970).

J. A. Wheeler's interpretation of Mach's Principle and generalization of orthodox general relativity found by C. Brans and R. H. Dicke are briefly presented. Critical analysis shows that neither Wheeler's nor the Dicke–Brans theory have much in common with what one is entitled to call Mach's Principle. (auth)

37927 SLOWLY ROTATING RADIATING SPHERE AND A KERR–VAIDYA METRIC. Murenbeeld, M.; Trollope, J. R. (Univ. of Alberta, Edmonton). Phys. Rev., D; 1: 3220-3(15 Jun 1970).

The problem of a spherically symmetric radiating body was first considered by Vaidya, who obtained what is often referred to as the "radiating Schwarzschild metric." It is well known that this metric, if expressed in radiation coordinates, differs from the Schwarzschild metric only in that the parameter m has been replaced by a function of retarded time. The parameter m of the Kerr metric is considered to be a function of the retarded time and an exact expression for the energy tensor is obtained. It is shown that if a/m is small then this energy tensor is appropriate for directed radiation. To this approximation [i.e., terms of order $(a/m)^2$ are neglected] the Landau-Lifschitz pseudotensor is used to show that the angular momentum radiated is $-m'a$. The metric is also used to describe the physical properties of a slowly rotating radiating spherical shell, and it is shown that (provided $2m/R \ll 1$) the radiation gives rise to surface pressures proportional to the momentum radiated. (auth)

37928 SCALAR–TENSOR THEORY AND GRAVITATIONAL WAVES. Wagoner, Robert V. (Cornell Univ., Ithaca, N. Y.). Phys. Rev., D; 1: 3209-16(15 Jun 1970).

An analysis of general scalar-tensor gravitation theory, containing two arbitrary functions of the scalar field, is presented. The weak-field limit is considered in detail, and predictions for the classical tests of gravitation theory are derived. A definite relationship between the light propagation and perihelion shift effects is found to hold under very general conditions. The theory of the detection of gravitational waves is also investigated, and the observable differences between the scalar and tensor components are indicated. Finally, the relationship between the properties of the source and its radiation is considered in the weak-source limit, and expressions for the rate of energy loss are derived. It is shown that the existing observational data are consistent with the possibility that the scalar field represents a major component of gravitational radiation from astronomical sources. (auth)

37929 DIFFERENTIAL EQUATIONS FOR PERTURBATIONS ON THE SCHWARZSCHILD METRIC. Edelstein, Lester A. (Univ. of Maryland, College Park); Vishveshwara, C. V. Phys. Rev., D; 1: 3514-17(15 Jun 1970).

Differential equations for perturbations on the Schwarzschild metric have appeared incorrectly in the literature. The correct set of equations is presented. (auth)

Scattering Theory

Refer also to abstracts 37588, 37743, 37777, 37823, and 37829.

37930 (COO-264-545) CROSSING REGGE TRAJECTORIES AND POLE-CUT RELATIONSHIPS. Oehme, Reinhard (Chicago Univ., Ill.). Apr 1970. Contract AT(11-1)-264. 24p. (EFI-70-23). Dep. CFSTI.

The general features of typical pole-cut relations with crossing Regge pole trajectories are considered. The possible shapes of the resulting physical pole trajectories are described. (auth)

37931 (ITF-70-17) PROBLEM OF AXIOMATIC FORMULATION OF MICROCAUSALITY AND THEOREMS OF THE POMERANCHUK THEOREM TYPE FOR THE "AVERAGED" AMPLITUDE. Lomsadze, Yu. M.; Sabad, E. P. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1970. 44p. Dep. CFSTI (U. S. Sales Only).

The problem of the effective formulation of the Bogolyubov microcausality principle for the asymptotical amplitude $T(\tau)$ without a priori purely mathematical postulating of whatever class of used generalized functions is discussed and solved. It is shown that if the "averaged" amplitude $[\tilde{T}(\kappa + \omega'), \varphi_D(\kappa)]$ exists owing to the microcausality it is necessarily bounded in the upper complex infinity by arbitrary linear exponents, and, consequently, the theorems of type of the Pomeranchuk theorem must be fulfilled for it under corresponding conditions for the real ω'. (auth)

37932 (LNF-69/79) SOME REMARKS ON INFINITE VENEZIANO REPRESENTATIONS. Note No. 461. Ferrara, S.; Grillo, A. F. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). 23 Dec 1969. 5p. Dep. CFSTI (U. S. Sales Only).

A class of integral representations for dual-resonance models is investigated which preserve all physical properties of the original Veneziano amplitude. (auth)

37933 (NP-18280) FURTHER REMARKS ON THE HIGH-ENERGY BEHAVIOUR OF RESONANCE POLES IN THE COMPLEX PLANE. Note No. 250. Paciello, M. L.; Taglienti, B. (Rome Univ. (Italy). Istituto di Fisica); Sertorio, L. (Rome Univ. (Italy). Istituto di Fisica. Istituto Nazionale di Fisica Nucleare, Rome (Italy)). 12 Jun 1970. 30p. Dep. CFSTI (U. S. Sales Only).

By using a model unitarity dynamical scheme various possible energy behaviors of the resonance widths at high energy are analyzed. Correspondingly Re $\alpha(s)$ is calculated. Moreover in the model it is also found that a linear trajectory may only result in the limit of vanishing pion mass. (auth)

37934 (RLO-1388-572) SIMPLE RELATIONS AMONG MULTIPLE SCATTERING AMPLITUDES. Friar, J. L. (Washington

Univ., Seattle. Dept. of Physics); Dean, N. W. (Vanderbilt Univ., Nashville, Tenn.). 1 Oct 1969. 8p. Dep. CFSTI.

It is shown that the amplitudes for multiple scattering in nuclei with $A \leq 4$ are related in a very simple way. It is therefore possible to calculate explicitly the contribution of double and triple scattering to the $\pi^{\pm}He^4$ total cross section if the $\pi^{\pm}He^3$ and $\pi^{\pm}p$ total cross sections are also known without the need of fitting the differential cross sections. These contributions contain information about Regge cuts as well as the nuclear structure. (auth)

37935 (RLO-1388-574) FORMAL MULTIPERIPHERAL INTEGRAL EQUATION BASED ON THE VENEZIANO MODEL. Peccei, R. D. (Washington Univ., Seattle. Dept. of Physics). [1969]. 7p. Dep. CFSTI.

An operator multiperipheral integral equation based on the full n-point Veneziano model is derived. This operator equation can be transformed into a c-number integral equation, involving an infinity of "hanging variables," whose form is similar to the equations obtained by Bardacki and Ruegg for the truncated Veneziano model. (auth)

37936 STATIONARY VALUES OF DIFFERENTIAL CROSS SECTIONS FOR ELASTIC SCATTERING. Azimov, S. A.; Arushanov, G. G. (Tashkent State Univ.). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 4, 103-8(1970). (In Russian).

General theoretical principles were used in order to determine the lower boundaries of differential cross sections for elastic scattering and its derivatives according to the transmitted momentum at the $t = 0$ point at high energies. The results are expressed by measured total cross sections. (R.V.J.)

37937 CORRESPONDENCE OF THE EQUATIONS OF THE MULTIPERIPHERAL AND MULTIREGGEON THEORIES OF INELASTIC PROCESSES. Dremin, I. M. (Lebedev Inst. of Physics, Moscow). JETP Lett. (USSR) (Engl. Transl.); 11: 178-81(5 Mar 1970).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 11: 272-7 (5 Mar 1970).

A single equation is written for inelastic processes, which reduces to the Bethe-Salpeter equation in most of the phase volume, and reduces to an equation of the Chew, Goldberger and Low type in the region of applicability of the multireggeon theory. (J.F.P.)

37938 THEORY OF THE SCATTERING OPERATOR. II. GRAPHIC REPRESENTATION AND ϕ^n MODELS IN PERTURBATION EXPANSION. Pagnamenta, A. (Rutgers-The State Univ., New Brunswick, N. J.); Rohrlich, F. Phys. Rev., D; 1: 1640-53 (15 Mar 1970).

The scattering-operator theory developed in a previous publication (I) is applied here to "ϕ^n" models. The fundamental equation for the scattering operator is solved in perturbation expansion. A suitable graphic representation provides diagrams for easier computation. The ϕ^3 model is solved to second and third order as an example, and off-mass-shell unitarity is checked explicitly. General arguments are presented to all orders to show in perturbation expansion, and for the preliminary formulation (I), that (a) for the models which are nonrenormalizable in the conventional theory ($n > 4$) there is no solution of the S-operator equation, and (b) for the renormalizable models ($n = 3$ and 4) the solution of the S-operator equation is identical to the renormalized conventional theory if the interaction is suitably chosen. The theory is finite throughout and involves no renormalizations. There are no cutoffs except a technical one for the space-time volume which is removed at the end of the calculation. (auth)

37939 LINEAR DEPENDENCES IN THE OPERATOR FORMALISM OF FUBINI, VENEZIANO, AND GORDON. Thorn, Charles B. (Univ. of California, Berkeley). Phys. Rev., D; 1: 1693-6(15 Mar 1970).

The Ward identities are considered within the operator formalism of Fubini, Veneziano, and Gordon. An operator A is constructed which, when acting on any state of the Hilbert space oscillators, gives a spurious state. It is then shown how one can use A to remove the contributions of spurious states in unitary-loop calculations. In particular, the result of Bardakci, Halpern, and Shapiro are obtained for the planar closed loop. No effort is made to prove that A generates the complete set of linear dependences. (auth)

37940 VARIATIONAL PRINCIPLE FOR THREE-PARTICLE SCATTERING. Pieper, S. C.; Schlessinger, L.; Wright, Jon (Univ. of Illinois, Urbana). Phys. Rev., D; 1: 1674-81(15 Mar 1970).

A variational principle is developed for three-body scattering which resembles in form a combination of the Kohn and Schwinger variational principles. Its principal advantage over previous formulations is that for energies above the three-body breakup threshold, it is not necessary to know the complicated correlation terms in the asymptotic part of the wave function. Application of the principle to both separable and local potentials is discussed. Results of calculations with separable potentials are presented for elastic and rearrangement processes beneath the breakup threshold. (auth)

37941 MULTIPARTICLE VENEZIANO FORMULAS CORRESPONDING TO MINIMAL NONPLANAR FEYNMAN DIAGRAMS. Mandelstam, Stanley (Univ. of California, Berkeley). Phys. Rev., D; 1: 1720-34(15 Mar 1970).

A new class of multiparticle Veneziano formulas is constructed. The amplitudes correspond to a subclass of nonplanar Feynman diagrams without internal vertices which we call minimal diagrams, just as the current multiparticle Veneziano formulas correspond to planar diagrams. For simplicity, diagrams with more than one crossed line were not examined. The r-point function is represented by an $(r-3)$-dimensional integral, as it is for planar diagrams. While the new formula has many properties in common with the old one, the three-particle channels of the Feynman diagram have a more complicated spectrum which suggests a system of three quarks. (auth)

37942 TWO-VARIABLE EXPANSION OF THE SCATTERING AMPLITUDE FOR ANY MASS AND SPIN AND CROSSING SYMMETRY FOR PARTIAL WAVES. Balachandran, A. P.; Case, W.; Modjtehedzadeh, M. (Syracuse Univ., N. Y.). Phys. Rev., D; 1: 1773-8(15 Mar 1970).

An infinite number of sum rules are derived for the process $a + b \rightarrow c + d$, where a, b, c, and d are particles of arbitrary mass and spin. Each of the sum rules involves a finite number of partial waves. They are implied by the crossing symmetry of the system and are complete. A classification of these relations into an independent set suggests a basis for the two-variable expansion of the scattering amplitude. The basis has the further virtue that it explicitly displays the kinematic singularities of the amplitude and the threshold and pseudothreshold zeros of the partial waves. The formalism is also valid for a decay process. The partial waves in the sum rules then refer to amplitudes where two of the three final particles are in a state of definite angular momentum, while the region of expansion becomes the Dalitz plot. (auth)

37943 SUPERPERTURBATION THEORY AND AMPLITUDE-PHASE APPROACH TO BOUND STATES AND THEIR PERTURBATIONS. Madan, Rabinder N. (Univ. of Massachusetts, Amherst). Phys. Rev., D; 1: 1654-60(15 Mar 1970).

In the amplitude-phase solution of the Schrödinger equation, it is shown that the bound-state energies are determined by continuing A^2 to negative energies and imposing appropriate boundary conditions at its origin. The function A^2 can be used to characterize both the regular and irregular solutions of the Schrödinger equation, with the result that in the Green's-function approach to bound-state perturbation theory, the energy shift in any order can be written in the form of an integral over known solutions. Two examples of second-order energy shift are discussed. (auth)

37944 NEW CRITERION FOR NONOSCILLATING HIGH-ENERGY BEHAVIOR. III. Gervais, J.-L. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France); Yndurain, F. J. Phys. Rev., D; 1: 1835-7(15 Mar 1970).

The analysis of nonoscillating scattering amplitudes carried on in two previous articles is completed by proving that, as conjectured, the asymptotic relations obtained also hold, in the mean, along physical directions. (auth)

37945 FORMAL MULTIPERIPHERAL INTEGRAL EQUATION BASED ON THE VENEZIANO MODEL. Peccei, R. D. (Univ. of Washington, Seattle). Phys. Rev., D; 1: 1843-4(15 Mar 1970).

An operator multiperipheral integral equation based on the full n-point Veneziano model is derived. This operator equation can be transformed into a c-number integral equation, involving an infinity of "hanging variables," whose form is similar to the equations obtained by Bardakci and Ruegg for the truncated Veneziano model. (auth)

37946 TIME-DEPENDENT FORMULATION OF THE SEMICLASSICAL APPROXIMATION IN COLLISION THEORY. II. Lebedeff, S. A. (Univ. of California, Davis). Phys. Rev., D; 1: 1583-90(15 Mar 1970).

In the present investigation the semiclassical approximation using the time-dependent formulation of the collision theory is extended. The previously used narrow-wave-packet approximation is improved by using, instead of expanding wave packets, wave packets that first contract and then expand. In addition, an integral equation is derived that allows one to obtain corrections to

the narrow-wave-packet approximation. Several of these corrections are presented. (auth)

37947 FACTORIZATION OF SATELLITE TERMS IN THE N-PARTICLE DUAL AMPLITUDE. Frampton, P. H. (Univ. of Chicago). Phys. Lett.; 32B: 195-8(22 Jun 1970).

Complete factorization of the N particle dual amplitude with satellite terms is exhibited explicitly in a formalism using harmonic-oscillator-like creation and destruction operators. (auth)

37948 ANALYSIS OF CONFORMAL-INVARIANT SCATTERING AMPLITUDES FOR THE TWO-DIMENSIONAL WORLD MODEL. Castell, L. (Max-Planck-Institut fuer Physik und Astrophysik, Munich). Commun. Math. Phys.; 17: 127-32 (1970).

The explicit form of the "conformal"-invariant "phase shift" analysis in the s-channel for a scattering process involving two incoming and two outgoing particles is derived for the two-dimensional world model. The high energy behavior of the scattering amplitudes is determined completely (up to a constant factor) by the requirement of "conformal" invariance. It is not possible to obtain this high energy limit by neglecting the masses right from the beginning. The main mathematical problem is the determination of the Clebsch-Gordan coefficients for $SU_2(1,1)$ in the momentum basis. (auth)

37949 RIEMANN SURFACES AND PARTIAL WAVE MODELS. Jones, R. B. (Queen Mary Coll., London). Commun. Math. Phys.; 17: 143-55(1970).

Within the context of simple partial wave models for elastic scattering the problem of uniformizing the partial wave amplitude and classifying its Riemann surface is studied. Starting with the analytic continuation of the amplitude an analysis of the Riemann surface is made through its group of covering transformations relative to a simpler base surface. A model based on the Yukawa potential is studied in this manner and the Riemann surface of interest is found to be the universal covering surface of the thrice punctured sphere. The uniformization of the amplitude can be done explicitly in this case by use of the elliptic modular function. In terms of the uniformizing variable, the original discontinuity relations for the amplitude then reduce to functional equations involving elements of the modular group. (auth)

37950 LOW-ENERGY EXPANISON FOR ELASTIC THREE-BODY SCATTERING. Amado, R. D.; Rubin, Morton H. (Univ. of Pennsylvania, Philadelphia). Phys. Rev. Lett.; 25: 194-7 (20 Jul 1970).

It is shown that the connected scattering amplitude for three free particles may be written (as the three-body energy E goes to zero) in the form $AE^{-1} + BE^{-\frac{1}{2}} + C\ln E + O(1)$ with A, B, and C completely determined by kinematics and the two-body scattering amplitudes at zero energy. (auth)

37951 PARAMETER-FREE REGULARIZATION OF ONE-LOOP UNITARY DUAL DIAGRAM. Neveu, A.; Scherk, J. (Princeton Univ., N. J.). Phys. Rev., D; 1: 2355-9(15 Apr 1970).

A parameter-free regularization of the one-loop planar unitary dual diagram is proposed, very similar to the renormalization in quantum field theory, compatible with duality, Regge behavior, unitarity, and crossing symmetry. (auth)

37952 QUASIPARTICLE CALCULATIONS FOR A THREE-BODY MODEL WITH LOCAL POTENTIALS. Alt, E. O.; Grassberger, P.; Sandhas, W. (Univ., Bonn). Phys. Rev., D; 1: 2581-9(1 May 1970).

The quasiparticle concept introduced by Weinberg for two-particle scattering has recently been applied to the three-body problem. It leads to an exact representation of the scattering matrix in terms of a modified Born series, the lowest order of which yields just the widely used separable-potential approximation. To test this method, the binding energies of three identical spinless particles interacting via Yukawa potentials, and the elastic scattering of one particle off a bound state of the other two, are calculated in zeroth- and first-order quasi-Born approximation. The calculation shows that the inclusion of the first quasi-Born correction greatly improves the zeroth-order, i.e., the separable-potential, results. Comparison is also made with other calculations recently performed in this model. (auth)

37953 UNITARITY UPPER AND LOWER BOUNDS ON THE ABSORPTIVE PARTS OF ELASTIC SCATTERING AMPLITUDES. Singh, Virendra; Roy, S. M. (Tata Inst. of Fundamental Research, Bombay). Phys. Rev., D; 1: 2638-51(1 May 1970).

Upper and lower bounds in the imaginary part of the elastic scattering amplitude of two spinless particles in the physical region are derived in terms of the elastic cross section σ_{el} and the total cross section σ_{tot}, using unitarity alone. The bounds derived are the best possible ones, given only the stated unitarity constraints. The upper bound for high energies and small values of the momentum transfer squared t has a particularly simple and "universal" form, $\mathrm{ImF}(s,t)/\mathrm{ImF}(s,0) \leq 1 - \frac{1}{8}\rho + \frac{3}{8}(\rho/9)^2 - (21/320)(\rho/9)^3 + \ldots$ if $2.5 \geq \rho \equiv (-t/4\pi)\sigma_{tot}^2(s)/\sigma_{el}(s)$, which depends on the particular scattering process and on the energy and momentum transfer only through the dimensionless parameter ρ. Explicit formulas and numerical values are given for the upper bound up to $\rho = 8.42$. The experimental curve of $(d\sigma/dt)/(d\sigma/dt)_{t=0}$ versus $4(-t)(d\sigma/dt)_{t=0}/\sigma_{el}$ is compared with the theoretical upper bound on $[\mathrm{ImF}(s,t)/\mathrm{ImF}(s,t=0)]^2$ versus ρ. The quantities plotted in the experimental and theoretical curves are the same if the unpolarized cross sections are spin-independent and purely absorptive in the diffraction-peak region. It is found that the experimental points for pp, $\bar{p}p$, π^+p, and π^-p scattering in the lab momentum range 6 to 13 GeV/c fall on a curve lying only slightly below the theoretical upper-bound curve, the difference being less than 10% for ρ in the range (0,3) and less than 25% for ρ in the range (3,5). It is noted that this experimental curve is universal. Unitarity lower bounds on the nth derivatives of the absorptive part at t = 0, and on the absorptive part for positive values of t within the Lehmann-Martin ellipse are also derived, in terms of σ_{el} and σ_{tot}. The corresponding bounds if σ_{tot} alone is known are also derived. (auth)

37954 SELECTION RULE IN QUARK MODEL AND THE REAL PART OF THE FORWARD SCATTERING AMPLITUDE. Shimodaira, H. (Univ. of Alberta, Edmonton). Phys. Rev., D; 1: 2696-2700(1 May 1970).

The selection rule derived from vector-meson decay is further investigated. It is found that the selection rule can be formulated consistently in the framework of field theory, using a quark model with three degrees of freedom. Applying this theory to evaluate the real part of the high-energy forward scattering amplitudes, it is found that the fit with experiment is quite satisfactory. (auth)

37955 SCATTERING THEORY OF RESONANCE MIXTURES. Stodolsky, L. (Faculte des Sciences, Orsay, France). Phys. Rev., D; 1: 2683-6(1 May 1970).

The scattering amplitude for scattering through resonances is derived and shown to be always a sum of simple Breit-Wigner terms even for nontrivial "particle mixtures." The formalism affords a particularly simple interpretation of the nonexponential decay or "dipole" phenomenon. (auth)

37956 ELASTIC SCATTERING BY A POTENTIAL OF COMPOUND SINGULAR TYPE. Cao-Xuan-Chuan; Ho-van-Hoa (Univ. of Saigon, South Vietnam). Compt. Rend., Ser. B; 270: 1077-80(27 Apr 1970). (In French).

Results from a previous study are generalized to the case of potentials of the form $\alpha/r^n - \beta/r^q$ and in particular to the Lennard-Jones potential. The analytic formula obtained gives the scattering angle θ as a function of the parameters of the potential. The result is simple for small θ angles and the expansion obtained seems valid for not too wide θ angles. (France)

37957 COLLIDING REGGE POLES AND CUTS. Kaus, P. (Univ. of California, Riverside); Zachariasen, F. Contracts AT(11-1)-68; UCR-34P107-111. Phys. Rev., D; 1: 2962-7(15 May 1970).

A class of models describing the collision of Regge poles and their associated Mandelstam branch cuts is described, from which it is concluded that Regge trajectories generally develop left-hand branch cuts as a result of such collisions, and in terms of which the singularities in the l plane of the partial-wave amplitude and the asymptotic behavior of the scattering amplitude can be discussed. (auth)

37958 MODEL AMPLITUDES CONTAINING ARBITRARY TRAJECTORIES, NONDEGENERATE DAUGHTERS, AND DUALITY. Swift, Arthur R.; Tucker, Robin W. (Univ. of Massachusetts, Amherst). Phys. Rev., D; 1: 2914-16(15 May 1970).

Model amplitudes are discussed which can accommodate nonlinear trajectories, satisfy duality, and have a nondegenerate spectrum of daughter resonances. (auth)

37959 METHOD FOR TESTING TOLLER ω DEPENDENCE IN THE MULTI-REGGE MODEL. Morrow, Richard A. (Dartmouth Coll., Hanover, N. H.). Phys. Rev., D; 1: 2884-8(15 May 1970).

Given data that are plausibly described by the multi-Regge model, it is shown that a distribution in a certain angle related to a triple subenergy (which in turn is related to ω) is flat if (1) the amplitude is independent of that subenergy and (2) a certain selection of data is made. The test can be applied to up to four internal vertices, thus allowing a complete analysis of ω dependence in reactions with six, seven, or eight particles in the final state. (auth)

37960 INFINITE SET OF MODELS SATISFYING CROSSING SYMMETRY, DUALITY, AND REGGE BEHAVIOR. Gardiner, C. W. (Syracuse Univ., N. Y.). Phys. Rev., D; 1: 2888-93 (15 May 1970).

A set of model amplitudes, characterized by two functions h(x) and $\omega(x)$, is given which satisfies the conditions of duality, crossing symmetry, and Regge behavior. These model amplitudes can be written as $G(\alpha(s), \alpha(t)) = \int_0^1 dx\, h(x)x^{-\alpha(t)}[\omega(x)]^{-\alpha(s)}$ and are generalizations of the beta function. The model has resonances of zero width, like Veneziano's model. It is proved that, under certain conditions, the model amplitude has Regge behavior as $s \to \infty$ with $\arg(-s) < \pi$ and t fixed, and that it dies exponentially as $s \to \infty$ with $0 < |\arg(s)| < \pi$ and u fixed, as does the amplitude in Veneziano's model. Specific examples of $\omega(x)$ and h(x) are given which satisfy all the required conditions, and it is shown that the models may be generalized to models which bear the same relation to the model $\Gamma(1-\alpha(s))\Gamma(1-\alpha(t))/\Gamma(1-\alpha(s)-\alpha(t))$ as the above models bear to the beta function. (auth)

37961 UNITARY NONPLANAR CLOSED LOOPS. Kaku. Michio; Thorn, Charles B. (Univ. of California, Berkeley). Phys. Rev., D; 1: 2860-9(15 May 1970).

It is shown how the Veneziano amplitude for an arbitrary nonplanar diagram can be calculated with one closed loop. In particular, the nonplanar diagram is explicitly calculated with four external particles and one "twisted vertex." If the amplitude is written as $M = \int d^4\Pi\, \mathcal{N}(\Pi)$, it is found that the result for $\mathcal{N}(\Pi)$ is periodic in the loop momentum Π, so that the expression for M does not converge. It is shown that, integrating over just one period, the correct result is obtained for the imaginary part of the amplitude in the s channel. Consequently, this is adopted as the definition of the unitary nonplanar amplitude. Finally, it is shown that with this redefinition, M satisfies the duality requirement that it be completely symmetric in the "untwisted" momenta. (auth)

37962 THREE-DIMENSIONAL FORMULATION OF THE RELATIVISTIC TWO-BODY PROBLEM AND INFINITE-COMPONENT WAVE EQUATIONS. Itzykson, C. (Inst. for Advanced Study, Princeton, N. J.); Kadyshevskii, V. G.; Todorov, I. T. Phys. Rev., D; 1: 2823-31(15 May 1970).

A relativistic quasipotential equation is derived from the conventional Hamiltonian formalism and old-fashioned "noncovariant" off-energy-shell perturbation theory in a similar way to that by which the four-dimensional Bethe-Salpeter equation is obtained from the off-mass-shell Feynman rules. The three-dimensional equation for the (off-energy-shell) scattering amplitude appears as a straightforward generalization of the nonrelativistic Lippmann-Schwinger equation. The corresponding homogeneous equation for the bound-state wave function and the normalization condition for its solutions are derived from the equation for the complete four-point Green's function. In order to obtain a solvable model, a simplified version of the quasipotential equation which still reproduces correctly the on-shell scattering amplitude and is consistent with the elastic unitarity condition is considered. It involves a "local" approximation to the potential $V(p-q)$ which defines the kernel of our integral equation (the integration being carried over a two-sheeted hyperboloid in the energy-momentum space). It is shown that for the scalar Coulomb potential $V(p-q) = \alpha/(p-q)^2$, our model equation is equivalent to a simple infinite-component wave equation of the type considered by Nambu, Barut, and Fronsdal. The energy eigenvalues for the bound-state problem are calculated explicitly in this case and are found to be O(4) degenerate (just as in the nonrelativistic Coulomb problem and in Wick and Cutkosky's treatment of the Bethe-Salpeter equation in the same approximation). (auth)

37963 CLASS OF DUAL AND FACTORIZABLE N-POINT FUNCTIONS. Balachandran, A. P. (Syracuse Univ., N. Y.). Phys. Rev., D; 1: 2770-2(15 May 1970).

An infinity of four-point functions which are dual, display Regge behavior, and contain no "ancestors" has been proposed independently by Bitar, Fairlie, and Gardiner. The corresponding N-point functions, consistent with duality and factorization are constructed. They too display Regge behavior and are devoid of "ancestors." The existence of these functions shows that the principles of duality and factorization are more general and flexible than any one of their concrete realizations. (auth)

37964 TOWARDS NEARLY CONSTANT BOUNDS FOR HIGH-ENERGY TOTAL CROSS-SECTIONS. Cornille, H. (Centre d'Etudes Nucleaires de Saclay, Gif-sur-Yvette, France). Nuovo Cim.; 68A: 317-38(21 Jul 1970).

Some rigorous results of quantum field theory suggest further assumptions restricting the behavior of scattering amplitudes at high energies and small momentum transfers in such a way as to ensure the existence of some weighted averages both of the real and imaginary parts of the forward amplitude. The latter prevent the total cross-sections from saturating high-energy bounds of the type $(\log s)^\epsilon$, $(\log\log s)^\epsilon$, $(\log(\log\ldots\log s)\ldots)^\epsilon$, p integer, ($\log$ p times), $\epsilon > 0$. If the property that the total cross section cannot saturate nearly constant bounds at infinity is violated there exist within the framework two possibilities. On one hand the amplitudes could be indefinitely oscillating. If not, there would appear particular zeros in linear combinations of the real and imaginary parts of the amplitudes. These zeros would be always present in the nearly forward asymptotic domain with energy as large and transfer as small as is desired. (auth)

37965 ANALYTIC CONTINUATION OF THE REGGE-POLE RESIDUE FUNCTION. Karpf, Armin D.; Liehl, Hermann J. (Univ., Freiburg i. B.). Z. Phys.; 235: 463-73(1970).

It is shown that the Regge residue function $\gamma(s)$ is particularly well suited for performing unitarity bootstrap calculation. The reason is that firstly $\gamma(s)$ has only one, viz. the right hand, cut along which its value can be evaluated from direct channel unitarity using a parameterfree representation for the partial wave amplitude S(l, s). Secondly its values for negative real argument follow directly from large-energy scattering with the exchange of one Regge pole in the crossed channel. These values can be evaluated from the same S(l, s) representation by partial wave sums. Then all one needs for a bootstrap system is an analytic connection of these 2 different pieces of information. It is shown that this can be achieved by logarithmic dispersion relations. This bootstrap system is supposed to compete favorably with the old unitary N/D calculations. Finally a new parameter free representation of S(l, s) is also proposed which applies equally well as that of Cheng. One main result is that Im $\alpha(s)$ has to decrease exponentially for large s. (auth)

37966 RECURSION RELATIONS FOR THE MULTI-VENEZIANO AMPLITUDE AND THE RESIDUE FUNCTIONS. Santhanam, T. S. (Inst. of Mathematical Sciences, Madras). Z. Phys.; 235: 205-10(1970).

It is shown that the multi-Veneziano amplitude is the generating function of multiple partitions. Recursion relations for the multi-Veneziano amplitude and the residue functions are explicitly given. (auth)

37967 SIGN OF THE ABSORPTIVE ELASTIC AMPLITUDE BELOW THE PHYSICAL THRESHOLD. MacDowell, S. W. (Yale Univ., New Haven). Contract AT(30-1)-2726. Phys. Rev., D; 1: 3501-5(15 Jun 1970).

It is shown that for elastic processes which have absorptive channels below the physical threshold, the absorptive partial-wave amplitude $a_l(s)$ has the sign of $(-1)^l$ for s below the physical threshold, where l is the orbital angular momentum. The result is valid for any stable particles of arbitrary spins. More generally, for elastic partial wave transitions between states of definite parity $P = \epsilon\eta_1\eta_2$ (where η_1 and η_2 are the intrinsic parities and $\epsilon = \pm 1$), the sign of the absorptive amplitude below threshold is that of ϵ. (auth)

37968 INCLUSION OF TOLLER-ANGLE DEPENDENCE IN THE MULTI-REGGE INTEGRAL EQUATION. Silverman, Dennis; Tan, Chung-I. (Princeton Univ., N. J.). Contract AF 49 (638)-1545. Phys. Rev., D; 1: 3479-95(15 Jun 1970).

The nonforward multiperipheral integral equation for the Reggeon-particle absorptive amplitude is generalized to include complete dependence on the Toller-angle variable. (auth)

37969 REGGE RESIDUE FUNCTIONS. Yamada, Masao (Univ. of Texas, Austin). Phys. Rev., D; 1: 3405-10(15 Jun 1970).

A discussion is given of Lovelace's conjecture that chiral symmetry for soft mesons plus the absence of exotic resonances yields Veneziano formula with no secondary terms. It is shown that the conditions of the above conjecture imply not only the exchange degeneracy of various Regge trajectories, but also the degeneracy of the reduced residue functions of the ρ and f or the ω and A_2 Regge families (including their daughter poles) of amplitudes of the type $a^\pm + A_\mu^\pm(V_\mu^\pm) \to a^\pm + A_\mu^\pm(V_\mu^\pm)$, where a^+ is any particle with positive charge, and $A_\mu(V_\mu)$ is the axial-vector (vector) current. The latter statement is proved for arbitrary values of t (or u) without suffering from the Regge cuts. This appears to be a necessary condition to write a Veneziano-type formula. (auth)

37970 RESIDUES OF REGGE POLES IN DIFFERENT CHANNELS. Yamada, Masao (Univ. of Texas, Austin). Phys. Rev., D; 1: 3410-13(15 Jun 1970).

Conservation of the axial-vector current is assumed, together with the soft-π-meson hypothesis and the pole dominance of the

vector and the axial-vector current. It is shown that there is a symmetry between the families of the residue functions of Regge poles in the t channel and those in the u channel for the s-channel helicity amplitude of the process $\rho^+(h_1) + A_1^+(h_2) \rightarrow \rho^+(h') + A_1^+(h')$. Here h_1 and h' are the helicities of the particles ρ and A_1, and they are restricted to 1 or −1. The direct relation between this symmetry and a Veneziano-type formula is discussed. A relation between the residues of the ρ and A_2 Regge poles is also given for the general helicity case. (auth)

37971 O(4) EXPANSION OF OFF-SHELL SCATTERING AMPLITUDES AND THE MOST GENERAL FORM OF REGGE TRAJECTORIES AND RESIDUES FOR ARBITRARY SPINS. I. Kuo, P. K. (Wayne State Univ., Detroit); Suranyi, P. Phys. Rev., D; 1: 3416-23(15 Jun 1970).

An analytic method for the discussion of broken symmetries is presented. After the demonstration of the power of the method on a quantum-mechanical example, it is applied to the question of broken SL(2,C) symmetry and families of Regge trajectories. As a result, all the constraints on daughter trajectory functions are obtained in a closed functional form for arbitrary Lorentz quantum numbers σ and M. (auth)

37972 O(4) EXPANSION OF OFF-SHELL SCATTERING AMPLITUDES AND THE MOST GENERAL FORM OF REGGE TRAJECTORIES AND RESIDUES FOR ARBITRARY SPINS. II. King, M. J. (Syracuse Univ., N. Y.); Kuo, P. K.; Suranyi, P. Phys. Rev., D; 1: 3424-36(15 Jun 1970).

The study of the contribution of a Regge-pole family to the scattering amplitude is continued. Total-spin states are constructed, which allow the off-shell scattering amplitude to be expanded in a series of representation functions of the Lorentz group. The contribution of the family is transformed into a form which strongly reminds one of a Lorentz-pole contribution, even at nonzero momentum transfers t. The most general dependence of the Regge-pole residues on the total helicity λ and daughter index κ is given in terms of two arbitrary functions of composite variables $\tau(j + 1)$ and $\Delta\lambda$, where $\Delta = \{[t - (m_1 - m_2)^2][t - (m_1 + m_2)^2]\}^{\frac{1}{2}}$. The contribution of a family to the scattering amplitude constructed from these residue functions and the trajectories given in a previous paper is the most general one satisfying all kinematic constraint relations at t = 0, pseudothreshold, and threshold. (auth)

37973 GENERALIZATION OF THE MULTIPARTICLE DUAL AMPLITUDES. Bitar, Khalil M. (American Univ., Beirut). Phys. Rev., D; 1: 3319-30(15 Jun 1970).

An integral representation for a set of infinitely many N-point amplitudes satisfying duality is presented. Two universal functions, which satisfy simple equations, enter into this representation. These equations have been studied previously and their solutions are well known. These generalized N-point amplitudes are not simply a series of the amplitudes already known. The latter form the set of special cases where only one of the two universal functions is involved. These amplitudes satisfy duality and invariance under cyclic permutation of the external momenta. Their resonance residues factorize and ancestors are absent. However, the possibility that the particle spectrum is richer than that of the ordinary amplitudes exists. It is also indicated how restrictions on these amplitudes may arise upon the implementation of unitarity. (auth)

37974 GALILEAN SYMMETRY, MEASUREMENT, AND SCATTERING AS AN ISOMORPHISM BETWEEN TWO SUBALGEBRAS OF OBSERVABLES. Corbett, J. V. (Centre National de la Recherche Scientifique, Marseille). Phys. Rev., D; 1: 3331-44(15 Jun 1970).

A model of quantum-mechanical scattering is given in terms of the Abelian subalgebras of observables which are associated with the initial preparation and final measurement procedures. The scattering is described by an operator, the S matrix, which defines an isomorphism between those two subalgebras. By using the concept of presymmetry for Galilean-invariant systems, these algebras are shown to be generated by the generalized momenta P′ which are related to the dynamical situation by $HP_{sc} = |P'|^2/2\mu$. Here H is the total Hamiltonian effective at the time of measurement, P_{sc} is the projection onto its absolutely continuous spectrum, and μ is the mass of the particle. The S matrix which is defined in this way gives the same formal expressions for the differential cross sections as the usual one, and it is automatically unitary. Furthermore, since the differential cross section is defined as a relative probability in terms of the results of the two measurement procedures, it can be finite even when the classical cross section is infinite. Scattering can therefore be defined in this model for spherically symmetric potentials which decrease as slowly as $r^{-\epsilon}$, for any $\epsilon > 0$, provided that the potential is repulsive at large separations between the particles. (auth)

37975 GENERAL FACTORIZATION OF THE n-POINT BETA FUNCTION INTO TWO PARTS IN A MOEBIUS-INVARIANT MANNER. Shapiro, Joel A. (Univ. of Maryland, College Park). Phys. Rev., D; 1: 3371-6(15 Jun 1970).

Using the Koba-Nielsen formalism for the generalized beta function, a general form for factorization into two pieces is developed in an entirely Möbius-invariant way. Ward identities for the vertex in the general configuration are derived in a manner which uses only the Möbius invariance of that factor. Special cases (still Möbius-invariant) of this procedure include the multiperipheral, semimultiperipheral, and symmetric factorizations already known. (auth)

37976 FEYNMAN-LIKE DIAGRAMS COMPATIBLE WITH DUALITY. II. GENERAL DISCUSSION INCLUDING NONPLANAR DIAGRAMS. Kikkawa, K. (Univ. of Wisconsin, Madison); Klein, S. A.; Sakita, B.; Virasoro, M. A. Contract AT(11-1)-881. Phys. Rev., D; 1: 3258-66(15 Jun 1970).

A general formulation of duality theory is presented that includes nonplanar Feynman-like diagrams. All diagrams, planar as well as nonplanar, are so classified that the diagrams in a given class are mutually connected by duality. A prescription is given for constructing an integral representation of the scattering amplitude for each class. Some fundamental properties of the duality relations are discussed. (auth)

Particle Accelerators

Refer also to abstracts 36467, 36670, 37408, 37550, 37601, 37662, 37680, and 38145.

37977 (AD-703241) POLARIZED ^{58}Co TARGET USING A ^{3}He-^{4}He DILUTION REFRIGERATOR. McCarthy, J. S.; Whitney, R.; Healey, D. C.; Parks, D.; Fisher, T. R. (Stanford Univ., Calif. High-Energy Physics Lab.). Nov 1969. Contract Nonr-225(67). 17p. (HEPL-619). CFSTI.

A 3He–4He dilution refrigerator has been used to cool a 32 gram polycrystalline cobalt rod to 0.034 degrees K. The rod is held in a longitudinal magnetic field of 6.5 kOe and has a nuclear polarization of 0.38. The cobalt piece will be used to study the scattering of polarized and unpolarized fast neutrons from polarized ^{58}Co. (auth) (USGRDR)

37978 (AD-703242) RECIRCULATION AT THE STANFORD HIGH-ENERGY PHYSICS LABORATORY. Jones, Eifionydd (Stanford Univ., Calif. High-Energy Physics Lab.). Aug 1969. Contract Nonr-225(67). 40p. (HEPL-609). CFSTI.

The length of the superconducting electron accelerator under construction at the High Energy Physics Laboratory is limited to some 500 feet. A conservative estimate of the final beam energy would then appear to be 2 GeV. The "newest" end-station, with very little rearrangement of the presently envisaged layout of experimental apparatus, may easily contain a 74 ft diameter 180 degrees bending magnet system. A second 180 degree bend tunneled underneath the H.E.P.L. offices would then complete the return path of the beam so that it may be injected at least once more into the accelerating structure to gain a final energy of about 4 GeV. The feasibility of such a recirculating scheme is studied. The final chapters of the report contain some ideas, in outline only, of how multiple recirculations might be achieved in fixed field superconducting magnets. (USGRDR)

37979 (AD-703308) DISCHARGE TYPE ION SOURCE WITH MAGNETIC BUNCHING. Noskov, D. A. Translated by W. Pearson from Russian Patent 223,943. 6p. (FTD-HT-23-570-69). CFSTI.

The invention involves a discharge-type ion source with magnetic bunching. The ion source consists of a sealed casing, a cylindrical anode, a permanent magnet for forming a magnetic field along the anode axis, and two disk shaped cathodes placed on the ends of the anode. One of these cathodes has an aperture for ion exhaust. (USGRDR)

37980 (BNL-50225) THE SLOW EXTERNAL BEAM AT THE BROOKHAVEN AGS. Brookhaven Lecture Series Number 86. Barton, Mark Q. (Brookhaven National Lab., Upton, N. Y.). 24 Sep 1969. 10p. Dep. CFSTI.

The development and operation of the slow external beam extraction system at the Brookhaven AGS is described. The system is composed of resonance perturbation sextupole magnets, the septum magnet, and the ejector magnet. It is expected that the extraction efficiency of the system can be tuned to 80 or 85%. (W.H.K.)

37981 (CEAL-1051) SEMIANNUAL REPORT FOR THE PERIOD, JULY 1–DECEMBER 31, 1969. Strauch, K.; Shurcliff, W. A. (Cambridge Electron Accelerator, Mass.). 10 Apr 1970. Contract AT(30-1)-2076. 51p. Dep. CFSTI.

Part I indicates the purpose of the contract, which is concerned with operating and improving the 6-GeV Cambridge Electron Accelerator. The main guiding committees are listed. Part II, on accelerator operation, shows that the total number of delivered prime-user hours and parasite-user hours was 2915. The number of delivered prime-time hours was 2257 compared to 2854 originally scheduled; the delivery factor was 0.79. The number of hours delivered to project bypass was 658, compared to 781 originally scheduled; the delivery factor was 0.84. Part III describes the 19 experiments underway or in preparation. Part IV summarizes progress on the colliding beam facility in which electron and positron beams, each with an energy as high as 3.5 GeV will collide with an available energy of 7.0 GeV in the center-of-mass system. The performance of the 130-MeV electron linac was improved and the Varian 130-MeV positron linac was installed and tried out successfully. The vacuum system of the accelerator ring was improved and we succeeded in achieving, with a 2.6-GeV constant-energy electron beam stored in the synchrotron, a 1/e lifetime of two hours. The bypass hardware also was improved and we succeeded in obtaining, with a 2-GeV electron beam stored in ring and bypass, a 1/e lifetime of 45 minutes. The 120-ft-long, low-beta bypass train in which the collisions are to occur was tuned and adjusted. Many studies were made of apertures, betatron frequencies, and other parameters. Construction of the on-line detector for analyzing results of the e^-e^+ collisions is nearing completion and many tests on component and component subassemblies have been completed successfully. Progress was made also on an optical detector and a magnetic detector. Part V summarizes the work done on various new projects, the most ambitious of which is the development of a source of polarized electrons. Part VI deals with safety and Part VII lists the major publications. (auth)

37982 (CERN-70-18) POSITIONING OF THE CERN INTERSECTING STORAGE RINGS: THE GEODETIC APPROACH. Gervaise, J. (European Organization for Nuclear Research, Geneva (Switzerland)). 30 Jun 1970. 29p. Dep. CFSTI (U. S. Sales Only).

The 800 MeV booster, the 28 GeV proton synchrotron, and the two rings of the ISR comprise about 4 km of tunneling, in which some 2000 components have to be positioned in relation to each other with an accuracy of 0.1 mm. The geodetic approach to the problem of positioning the ISR components is described. Also, a comparison is made with the solutions used for the 28 GeV proton synchrotron and 800 MeV booster, and an approach is made to the problems which will be posed by the future 300 GeV machine. (W.H.K.)

37983 (CERN-Trans-70-4) AUTOMATIC PRECISE FIELD MEASUREMENTS IN MAGNETS OF THE IHEP ACCELERATOR. Vagin, A. I.; Kozlov, V. V.; Komarov, V. V.; Korol'kov, I. Ya.; Kuz'min, V. F.; Lednev, A. A.; Matyukhin, S. S.; Suraev, V. V.; Shovgenev, P. P. (Akademiya Nauk SSSR, Moscow. Radiotekhnicheskii Institut). Translated for European Organization for Nuclear Research, Geneva, Switzerland, from report NTD-687. 14p. Dep. CFSTI (U. S. Sales Only).

Numerosity and diversity of accelerator magnets as well as numerosity of primary measurement data have necessitated development of an automatic measuring system. This system provides for measurements both of local and integrated fields by local probes whose output is processed to take a digital punch-card form. Card data are then processed by a computer to obtain a final result of measurement. The system was used for series calibration measurements of the circular magnet packages, for measurements of typical characteristics of these packages, and measurements of fringe fields in straight sections of the circular magnet. (auth)

37984 (CERN-Trans-70-6) ORBIT MONITORING SYSTEM FOR A 70-GeV PROTON SYNCHROTRON. Bol'shakov, Yu. D.; Gertsev, K. F.; Ivanov, Yu. S.; Kuz'min, A. A.; Rubchinskii, S. M.; Uvarov, V. A. (Akademiya Nauk SSSR, Moscow. Radiotekhnicheskii Institut). Translated for European Organization for Nuclear Research, Geneva, Switzerland, from report NTD-6827. 10p. Dep. CFSTI (U. S. Sales Only).

The technique used to determine a closed orbit of the proton beam by measuring the beam position at 30 and 75 points along the accelerator azimuth is described. A brief description and characteristics of the multichannel orbit monitoring system for the Serpukhov Synchrotron are given. General results of system testing and measuring a closed orbit are reported. (auth)

37985 (JINR-P9-5047) A SYSTEM OF CURRENT CORRELATION OF THE 2-METER JINR ISOCHRONOUS CYCLOTRON. Shelaev, I. A.; Ivanenko, A. I.; Kozlov, S. I.; Oganesyan, R. Ts.; Chugreev, V. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1970. 10p. (In Russian). Dep. CFSTI (U. S. Sales Only).

Experimentally obtained magnetic and vacuum characteristics of the system of current correlation of the 2-metre isochronous cyclotron are presented. The results of experiments on studying the effects of adjusting coils on the parameters of the accelerated ion beams are given. (auth)

37986 (LA 4463) QUARTERLY STATUS REPORT ON THE MEDIUM-ENERGY PHYSICS PROGRAM FOR THE PERIOD ENDING APRIL 30, 1970. (Los Alamos Scientific Lab., N. Mex.). Jun 1970. Contract W-7405-eng-36. 42p. Dep. CFSTI.

A summary of research on the medium-energy physics program at Los Alamos is presented for the period ending April 30, 1970. This review covers the accelerator structures, the RF power system, accelerator control and instrumentation, accelerator physics, the experimental area, LAMPF users group and scheduling and facility construction, and physics research. (J.F.P.)

37987 (LA-tr-70-5) RELOADING METHOD OF PROTON INJECTION IN ACCELERATORS AND ACCUMULATORS. Dimov, G. I. (Akademiya Nauk SSSR, Novosibirsk. Institut Yadernoi Fiziki). Translated by A. Cernicek (Los Alamos Scientific Lab., N. Mex.), from report IIF-304. 23p. Dep. CFSTI.

The theory of multi-turn proton injection in synchrotrons by the reloading method is described. Beams of H^0 or H^- are injected into the proton orbit for the reloading injection of protons. Reloading processes, scattering on target nuclei, ionization losses of energy, and the capture coefficient are discussed. (W.H.K.)

37988 (LNF-69/78) THE 12 MeV MICROTRON USED AS INJECTOR OF THE FRASCATI ELECTRON-SYNCHROTRON. Note No. 460. Bizzarri, U.; Vignati, A. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). 19 Dec 1969. 33p. Dep. CFSTI (U. S. Sales Only).

The design and operation of the microtron using a hot cathode electron source for increased peak current are described. The basic theory of the microtron, voltage gain of electrons crossing the cavity, stable phase theory, hot cathode injection, technology of the LaB_6 electron emitter for the hot cathode source, magnetic field, beam extraction, magnet details and vacuum system, and the cavity and microwave system are discussed. (W.H.K.)

37989 (MPS/Int. CO-62-15) THE INDUCTION TYPE BEAM MONITOR FOR THE PS ("HEREWARD TRANSFORMER"). (European Organization for Nuclear Research, Geneva (Switzerland)). 6 Dec 1962. 31p. Dep. CFSTI (U. S. Sales Only).

This report describes the operating principles of the induction beam monitor, some factors affecting its design, and the results obtained. The instrument is based on a prototype equipment designed by H. G. Hereward and the object of the exercise was to build a fully operational version with, if possible, an extended frequency range to permit observation of spiralling beam phenomena. (auth)

37990 (MPS/Int. CO-65-3) PROPOSAL FOR AN INDUCTION TYPE BEAM MONITOR FOR THE SLOW EJECTED BEAM OF THE CPS. Unser, K. (European Organization for Nuclear Research, Geneva (Switzerland)). 10 Feb 1965. 17p. Dep. CFSTI (U. S. Sales Only).

An electromagnetic beam monitor system for the slow ejected beam of the CERN proton synchrotron is proposed. The beam current induces a signal in the winding of an observation toroid, and the signal processing circuit for readout is described. (W.H.K.)

37991 (NP-18296) LONGITUDINAL BEAM RF FIELD INTERACTIONS IN A LINEAR ACCELERATOR CAVITY OF HIGH Q-VALUE. Heller, F.; Kuntze, M.; Mittag, K.; Vetter, J. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Experimentelle Kernphysik). Dec 1969. 50p. Dep. CFSTI (U. S. Sales Only).

A particle beam passing through an rf accelerator cavity can excite electromagnetic oscillations or disturb oscillations excited by a generator. Especially, unstable excitations (causing beam blow up) and considerable frequency shifts may occur, if losses in the cavity walls are small. A special but important case is the "longitudinal" effects due to an interaction between the charged particles and an electric field component in the beam direction, i.e., in accelerating modes. In this report all longitudinal interaction effects are described by a general formalism as far as linear approximations are possible. Formulae are given which can be compared with experimental results and yield information about possible disturbances of a linear accelerator by an excitation of unwanted modes. (auth)

37992 (NP-18302) EFFECTS OF IRREGULARITIES OF CAVITY RESONATOR PERIODIC STRUCTURES ON THE ELECTROMAGNETIC FIELD IN THEM. Siefkes, Harm (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Experimentelle

Kernphysik). Jul 1969. 36p. (In German). Dep. CFSTI (U. S. Sales Only).

The consequences of inaccuracies in manufacturing periodic cavities have been investigated with the aid of a coupled circuit model by means of first order perturbation theory. After examining the model and its applicability the formulas are derived, discussed and evaluated for randomly distributed perturbations. Furthermore some results of determining the region of validity of these formulas by comparison with an exact numerical treatment are presented. (auth)

37993 (NP-tr-1895) PRELIMINARY ASPECTS OF COMPUTERISED ACQUISITION AND COMMAND ON THE CERN PROTON SYNCHROTRON AND BOOSTER. Asseo, E.; Van Der Beken, H. Translated by C. R. Brightmore (Atomic Energy Research Establishment, Harwell, Eng.), from CERN Internal Note MPS/Int.CO 67-12. 12p. Dep. CFSTI (U. S. Sales Only).

The status of the computer-based data acquisition and control system for the CERN proton synchrotron is outlined. (W.H.K.)

37994 (NP-tr-1906) IBM 1800 FOR THE CERN PROTON SYNCHROTRON: SPECIFICATIONS AND CONFIGURATION. Van Der Beken, H. Translated by C. R. Brightmore (Atomic Energy Research Establishment, Harwell, Eng.), from CERN Internal Note MPS/CO.Comp.66-10. 6p. Dep. CFSTI (U. S. Sales Only).

The characteristics of the components of the IBM 1800 data acquisition and control system for the CERN proton synchrotron are summarized. A flow chart of the configuration is included. (W.H.K.)

37995 (ORNL-tr-2328) INDUCED RADIOACTIVITY AT THE IHEP PROTON SYNCHROTRON. Golovachik, V. T.; Britvich, G. I.; Lebedev, V. N. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov. Institut Fiziki Vysokikh Energii). Translated for Oak Ridge National Lab., Tenn., from report IHEP-69-76. 13p. Dep. CFSTI.

Graphs are presented for the induced radioactivity distribution along the accelerator, induced radioactivity buildup in the zone of the target station, and decay curves of induced radioactivity. Also, the γ-spectrum of the vacuum chamber, contributions of identified isotopes to the dose of γ rays, dose per unit of γ flux as a function of cooling time, and isodose curves of induced radioactivity in the zone of the target station are presented diagrammatically. (W.H.K.)

37996 (PPAD-674-E) MACHINERY ROOM DATA ACQUISITION SYSTEM. Hochman, Stanley (Princeton-Pennsylvania Accelerator, Princeton, N. J.). 22 Apr 1970. Contract AT(30-1)-2137. 5p. (CONF-700524-1). Dep. CFSTI.

From Digital Equipment Corporation Users Society Spring Symposium, Atlantic City, N. J.

The data acquisition system described is designed to record via printed teletype output, 100 points of temperature, pressure, voltage, liquid flow, current, and power information from a machinery room that supports a physics nuclear accelerator. (auth)

37997 (SLAC-120) TWO-MILE ACCELERATOR PROJECT. Quarterly Status Report, January 1-March 31, 1970. (Stanford Linear Accelerator Center, Calif.). Jun 1970. Contracts AT-(04-3)-400; AT(04-3)-515. 69p. Dep. CFSTI.

A status report on the Stanford Linear Accelerator Project covering the period January 1, 1970 to March 31, 1970 is presented. Topics included are accelerator and research area operations, accelerator and research area equipment development, and physics research equipment development. (auth)

37998 (SLAC-PUB-753) THE SLAC LH_2 TARGET CONTROL SYSTEM. Pierce, W. B. (Stanford Linear Accelerator Center, Calif.). Jun 1970. 32p. (CONF-700503-4). Dep. CFSTI.

From 3rd International Conference on Magnet Technology, Hamburg, Germany.

The control system for the liquid lithium hydride target at the Stanford Linear Accelerator is described. The silicon diode probe for indicating the lithium hydride level, the semiautomatic vacuum system, the air flow monitor, the H_2 detectors, and the pressure transducers are described. (W.H.K.)

37999 (SLAC-PUB-762) A SYSTEMATIC PROCEDURE FOR DESIGNING HIGH RESOLVING POWER BEAM TRANSPORT SYSTEMS OR CHARGED PARTICLE SPECTROMETERS. Brown, Karl L. (Stanford Linear Accelerator Center, Calif.). Jun 1970. 15p. (CONF-700503-3). Dep. CFSTI.

From 3rd International Conference on Magnet Technology, Hamburg, Germany.

By extrapolating the systematics of the general first- and second-order theory of beam transport optics to include higher order multipole terms, it has been possible to evolve a simple, step by step, procedure for the design of high resolving power static-magnetic beam transport systems. The choice of the appropriate dipole and quadrupole elements for a given system may be determined once the resolving power, solid angle, momentum range and detector system of the instrument have been specified. The partial derivative of any nth-order aberration coefficient with respect to an nth-order multipole component located anywhere in the system has been derived. From this "coupling coefficient," the strength and the optimum location of multipole element(s) to correct or modify a given aberration or group of aberrations is uniquely determined. (auth)

38000 ELECTRON ACCELERATION BY AN ALTERNATING PERIODIC STRUCTURE. Kikuchi, Takuo; Takata, Koji (Toshiba Research and Development Center, Kawasaki, Japan). Jap. J. Appl. Phys.; 9: 679-90(Jun 1970).

The design and some experimental results of a 30-cm-long standing wave electron linac are described. The accelerating tube is an alternating periodic structure (APS) and fed with 2856 MHz rf power in 2 μsec pulses by a tunable magnetron (Toshiba M4543). With a peak power of 3 MW, 4-MeV 100 mA beam pulses are produced. Peak accelerated currents of 400 mA with 1 μsec duration are obtained for 50-keV 1 A injection currents. This linac will be used for radiation therapy. (auth)

38001 THE 1 MILLION VOLT VAN DE GRAAFF GENERATOR OF THE ATOMKI. Bacskay, Gy.; Berecz, I.; Bodizs, D.; Kiss, A.; Koltay, E.; Papp, I.; Schadek, J.; Somorjai, E.; Szabo, Gy.; Szalay, S. ATOMKI (At. Kut. Intez.) Kozlem.; 11: 125-35(Dec 1969). (In Hungarian).

A brief description of a 1 million volt Van de Graaff generator is given. The machine was planned and built for the purpose of test experiments connected with accelerator development and for nuclear reaction measurements. (auth)

38002 CERN'S NEW ACCELERATOR PROPOSAL. Burhop, H. S. (University Coll., London). New Sci.; 46: 574-6(18 Jun 1970).

In 1963 the European Committee for Future Accelerators (ECFA) consisting of physicists and accelerator engineers from the countries that operate CERN, after an exhaustive study of the future need of Europe in this field, came up strongly in favor of two proposals. 1. The construction at CERN of a novel device known as proton intersecting storage rings (ISR) at a cost (transformed to present day prices) of about £30 million. 2. The construction of a new accelerator to produce protons of 300 GeV energy, more than ten times the energy of the CERN Proton synchroton, at a present day cost of about £190 million. When the recommendations of ECFA were put to the governments of the CERN member states, agreement to go ahead with the ISR was eventually reached while the 300-GeV proposal was sent back to the physicists for further study. In the ISR two beams of protons each of energy 28 GeV collide almost head on with each other, and one is able to study phenomena which could be produced only by protons of 1700 GeV energy hitting a stationary target. In the ISR, however, the event rate is much smaller than with a conventional machine and in other ways it is much less versatile. The subsequent train of events concerning the 300 GeV accelerator are outlined and the recent complete reappraisal of machine design, citing and cost by J. B. Adams is examined. The facilities which will be available if the new project is approved are discussed. (UK)

38003 ENERGY STABILIZATION SYSTEMS FOR VAN DE GRAAFF GENERATORS. Paal, Andras. ATOMKI (At. Kut. Intez.) Kozlem.; 11: 151-61(Dec 1969). (In Hungarian).

A review of stabilization systems for Van de Graaff accelerators is given. Diagrams of an equivalent circuit of the Van de Graaff accelerator, attenuation due to the accelerator time constant as a function of frequency, and the transfer function of the magnetic analyzer and slit amplifier are presented. Feasible combinations of error detectors and controllers are described. A standard servo-mechanism analysis method for the control system is briefly described. (W.H.K.)

38004 THEORY OF THE RESONANT BEAM EJECTION FROM SYNCHROTRONS. Kobayashi, Y. (Tokyo Univ.). Nucl. Instrum. Methods; 83: 77-87(1970).

The resonant beam ejection has been applied to most of the existing synchrotrons and is an established technique for the circular accelerators at present. The purpose of this report is to develop an analytical approach to this subject and to give relatively simple expressions useful for practical applications. The accuracy of this theory has been proved to be fairly good by numerical calculations. The analysis shows that better performance characteristics are expected for the third resonance ejection rather than the integer resonance ejection. (auth)

38005 HIGH FREQUENCY ION SOURCE WITH RADIAL EXCITATION FIELD. Tawara, H.; Sonoda, M. (Kyushu Univ., Fukuoka). Nucl. Instrum. Methods; 83: 67-71(1970).

A high frequency ion source with radial excitation field is described and compared with a usual axial excitation type. In the former type, the plasma is localized near excitation elecrodes. The energy of emitted ions is considerably lower than an applied probe potential. Ionizing electrons were not lost by random scattering at the protruding parts of the discharge vessel as in the case of the axial excitation type because these were not included in the ionization region in the radial excitation type. The operation is more stable and the startup is easier than in an ordinary axial excitation type. (auth)

38006 THEORETICAL CONSIDERATION OF A SPIN-POLARIZED ELECTRON SOURCE BASED ON ELASTIC ELECTRON-HYDROGEN SPIN-EXCHANGE COLLISIONS. Krisciokaitis, R. J.; Tsai, Wu-yang (Harvard Univ., Cambridge, Mass.). Contract AT(30-1)-2076. Nucl. Instrum. Methods; 83: 45-57(1970).

This paper describes the theoretical basis of a pulsed source of polarized electrons that, in principle, should yield very high intensity and polarization. The expected average intensity would be several orders of magnitude greater than anything previously attained or proposed. The method employs polarization transfer from state selected and mechanically trapped (as in hydrogen maser) neutral hydrogen atoms in the $F = 1$, $M_F = 1$ state to magnetically trapped low energy ($\lesssim$10 eV) electrons through the mechanism of elastic electron-hydrogen spin-exchange collisions. There are two important features of this device. One is that a large interaction volume between electrons and hydrogen atoms is to be used by utilizing the capability to trap state selected hydrogen atoms without serious depolarization. The other is the unique method of filling and trapping low energy electrons in sufficient density without exciting the hydrogen. It is shown that by using an interaction volume of $\approx 10^3$ cm^3 or so, and electron density of $\approx 10^9$ e$^-$/cm^3, it is possible to develop a pulsed source (10^3Hz) yielding $\approx 10^{14}$ e$^-$/sec, with polarization $P_e \gtrsim 0.9$. The source emittance at a source energy of $\approx$100 keV will be comparable to that of present nonpolarized thermionic sources used with linear electron accelerators. A prototype device which is now being placed in operation will also be discussed. The final device (or modified version of it) could be useful in atomic physics, nuclear physics, and high-energy particle physics. (auth)

38007 QUADRUPOLE AND QUADRUPOLE-OCTUPOLE LENSES. Shpak, E. V. ATOMKI (At. Kut. Intez.) Kozlem.; 11: 175-86(Dec 1969). (In Russian).

A brief review is given of the advantages and uses of quadrupole-octupole lenses and the new designs and construction of these lenses. The tendencies of replacing the quadrupole lenses by quadrupole-octupole in order to improve the focusing by correcting the spherical aberrations of the third order are discussed. 28 references. (R.V.J.)

38008 INVESTIGATIONS ON THE FIELD OF ASYMMETRIZED QUADRUPOLE LENSES. Bodnar, Laszlo; Koltay, Ede; Szabo, Gyula. ATOMKI (At. Kut. Intez.) Kozlem.; 11: 137-50(Dec 1969). (In Hungarian).

The results of experimental investigations on the field of asymmetrized electrostatic and magnetic quadrupole lenses are presented and compared with the results of third order potential functions. The measured and calculated data agree within the experimental errors. (auth)

38009 SELECTION AND OPTIMIZATION OF THE DEFINING GEOMETRICAL PARAMETERS OF A LONG IRON-FREE SUPERCONDUCTING MAGNETIC QUADRUPOLE LENS FORMED BY COILS WITH TRAPEZOIDAL CROSS SECTION. Mouza, J.-C. (CNRS, Orsay, France). Nucl. Instrum. Methods; 83: 139-11 (1970). (In French).

Current distributions producing a quadrupolar field configuration with constant gradient in an iron-free lens with circular aperture are studied. The problem is solved in a two-dimensional geometry, that assumes the conductors to be infinitely long. In this paper a theoretical analysis is developed of the optimization of the parameters defining the trapezoidal cross sections of the superconducting quadrupole lens coils, to obtain the best optical quality in the whole aperture. (auth)

38010 MODEL FOR PARTICLE MOTION IN BETATRON CHAMBER UPON EXCITATION OF PARAMAGNETIC RESONANCE OF RADIAL FREE OSCILLATIONS. Anokhin, V. P.; Kononov, B. A.; Ryzhkov, B. A. (Tomsk Polytechnic Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 4, 39-43(1969). (In Russian).

A model is given for amplitudes and phase dynamics of radial free oscillations of electrons with paramagnetic resonance. The obtained solutions are discussed and compared with solutions found by other methods. (tr-auth)

38011 STRONG FOCUSSING IN A MAGNETIC HELICAL QUADRUPOLE CHANNEL. Pearce, R. M. (Univ. of Victoria, Can.). Nucl. Instrum. Methods; 83: 101-8(1970).

The trajectories of a charged particle have been calculated in a helical magnetic quadrupole channel in which the four pole tips are concentric helices performing one rotation in an axial distance λ (no drift lengths). In cases where the maximum displacement of the particle from the optic axis is always small (say less than $\lambda/20$) then in a coordinate system which rotates with the channel, the trajectories have modes with two different frequencies. There is a cosine-like and sine-like mode at each frequency and any general trajectory can be written as a linear combination of the four modes. The helical quadrupole channel is stronger focusing than the equivalent alternating gradient channel with the same bore and gradient and no drift lengths. In cases where the particle displacement exceeds $\lambda/20$, the axial magnetic field becomes appreciable, non-linear terms appear in the equations of motion, the modes cease to exist, and the channel becomes more strongly focusing. (auth)

38012 ARRANGEMENT FOR HELIUM TRAPPING AT THE U-120 CYCLOTRON. Filipson, A. N.; Taut, T. (Joint Inst. for Nuclear Research, Dubna, USSR). Rev. Roum. Phys.; 14: 1029-34(1969). (In Russian).

The problem of physical adsorption of air and water vapors on carbon and silica gel is considered. Using isotherms which give the best agreement with the experimental data, filters designed for the retention of O_2 and N_2 are calculated. Helium-3 (or the He-3 + He-4 mixture) passes freely through the installation and is used again. With the heat-absorption equation the regeneration furnace is calculated. A description of the helium purification installation for the ion source for the U-120 cyclotron is given. (tr-auth)

38013 EXPERIMENTAL INVESTIGATION OF COMPUTER MONITORING AND CONTROL FOR THE CORNELL 10-GeV ELECTRON SYNCHROTRON. Sutter, David Franklin. Ithaca, N. Y.; Cornell Univ. (1969). 221p.

Thesis.

A limited computer monitoring and control system has been developed and placed in operation for the Cornell 10 GeV electron synchrotron, using the time-sharing capabilities of an IBM 1800 computer. The computer has been interfaced to the synchrotron's multiplex control system and programs written which provide readout and reset of 98 low energy correction coils and a readout of injected turn electron beam position data. In addition, the computer provides monitoring and limited reset of synchrotron injection and main timing variables. Special monitoring circuits allow the computer to record data for injected charge and circulating electron current and to display analyzed data from these sensors on the control console typewriter. The computer has been made to assume some of the routine data logging responsibilities of the synchrotron operator. A set of programs has been written for automatic optimization of the average circulating electron current by the method of localized orbit distortions of the injected electron beam. (Diss. Abstr.)

38014 THE USE OF EXISTING AND THE POSSIBILITY OF DESIGNING NEW SOVIET ACCELERATORS OF HEAVY PARTICLES FOR RADIUM TREATMENT. Dzhelepov, V. P.; Gol'din, L. L. (Joint Inst. for Nuclear Research, Dubna, USSR). Med. Radiol.; 15: No. 5, 19-28(May 1970). (In Russian).

The physical peculiarities of beams of heavy particles (protons, alpha-particles, heavy ions, pi-minus-mesons) and their relative merits and effectiveness from the viewpoint of radium treatment of deep-seated pathological foci are discussed. Proton beams obtained by means of accelerators of heavy particles in the USA, Sweden and USSR, the project of reconstruction of the synchrocyclotron of the Laboratory of Nuclear Problems (Dubna) for the improvement of the characteristics of medical beam, as well as the possibility of designing specialized proton accelerators for medical purposes are discussed. (auth)

38015 FORMATION OF DOSE FIELDS ON PROTON BEAM OF ITEP ACCELERATOR. Blokhin, S. I.; Gol'din, L. L.; Kleinbok, Ya. L.; Lomanov, M. F.; Onosovskii, K. K.; Pavlonskii, L. M.; Khoroshkov, V. S. (Inst. of Experimental and Theoretical Physics, Moscow). Med. Radiol.; 15: No. 5, 64-8(May 1970). (In Russian).

The technique for formation of dose fields of wide proton beams along the axis of the beam and in the transverse direction is discussed as well as the constructive features specific for the equip-

ment used for these purposes. Dose fields were formed on a medico-biological proton beam of the ITEP accelerator. (auth)

38016 HIGH CURRENT DENSITY 600 keV MULTIMOMENTUM ACCELERATOR. Hilton, J. L.; Hamilton, G. W. (Aerojet-General Corp., San Ramon, Calif.). Rev. Sci. Instrum.; 41: 944-51(Jul 1970).

A new type, long focal length, 600 keV, continuous high current density accelerator is described. Beam focus is obtained from a combination of five magnetic and electrostatic lenses. The construction and preliminary multimomentum operation are outlined, wherein a total current of 80 mA at a current density of approximately 40 mA/cm^2 was obtained. A simple theory for maximum focused beam current density is developed for semispace charge-neutralized machines which compares favorably with the experimental results. Problems such as back-streaming electrons and required vacuum conditions are discussed. Focus and beam optics are considered for simultaneous acceleration of a multicomponent beam composed of the several molecular ions of normal hydrogen and of a hydrogen–deuterium mixture. (auth)

38017 FRINGING FIELD EFFECT OF DEFLECTING MAGNET. Ezoe, Hirohiko (Inst. of Physical and Chemical Research, Yamato, Japan). Rev. Sci. Instrum.; 41: 952-6(Jul 1970).

The fringing field effect of a deflecting magnet on a charged particle trajectory is examined through its strict analytical expression, and thus the limit of approximation to be applied is discussed. The slope and location of a particle trajectory in the median plane are given, and, for z focusing, the focal length and the location of an assumed thin lens are derived showing how the lens concept can be introduced. The present analysis will give the procedure to obtain the higher order calculations if they are needed. (auth)

38018 IMAGE INSTABILITY IN HIGH CURRENT LINEAR ACCELERATORS. Woods, C. H. (Univ. of California, Livermore). Rev. Sci. Instrum.; 41: 959-62(Jul 1970).

In high current linear accelerators there may be instability in the coherent lateral motion of the particles caused by the electrostatic image of the beam. Appropriate placement of focusing magnetic lenses (the type normally employed to prevent symmetric radial expansion of the beam) can be used to control the lateral motion. Criteria for stability are derived. (auth)

38019 LOW ENERGY ION ACCELERATOR FOR HOT ATOM CHEMICAL RESEARCH. Pohlit, H. M.; Erwin, W. R.; Reynolds, F. L.; Lemmon, R. M.; Calvin, M. (Univ. of California, Berkeley). Rev. Sci. Instrum.; 41: 1012-20(Jul 1970).

An ion accelerator is described that delivers magnetically separated ion currents of 0.1 to 20 μA at 5 eV to 10 keV energy into targets of 5 mm^2. An electrostatic decelerator in front of the target permits continuous lowering of the ion energy of ca. 5 eV. The accelerator has been used mainly for the production of $^{14}C^+$ ion beams from $^{14}CO_2$ for the study of the hot atom chemistry of carbon in solid benzene. The ion source is of all metal construction and is a straight capillary arc type. It delivers C^+ currents of approximately 2 μA, obtained at 0.2 to 0.5% efficiency from the $^{14}CO_2$ source gas. (auth)

38020 INFLUENCE OF THE BACKWARD WAVE ON THE RADIAL MOTION OF PARTICLES IN AN ELECTRON STATIONARY-WAVE LINEAR ACCELERATOR OF LOW ENERGY. Boussoukaya, Mustapha; Septier, Albert (Paris Univ., Orsay, France). Compt. Rend., Ser. B; 270: 1317-20(25 May 1970). (In French).

The numerical integration of the motion equation in an electron stationary-wave linear accelerator of low energy and low current reveals an important focusing effect due to the reflected wave at low energies. The convergence of a short resonating cavity may be approximately calculated. (France)

38021 ISU: (SINGLE-WIRE INDUCTION). NEW SYSTEM FOR OBTAINING VERY HIGH dc VOLTAGES AND THE EQUIPMENT FOR ELECTROSTATIC ACCELERATORS. Pierson, A.; Pequet, R.; Lalande, J.; Gerbier, R. (CEA, Paris). Rev. Gen. Elec.; 79: 225-30(Mar 1970). (In French).

It is possible to achieve a power supply transfer between magnetic circuits by using a single turn of conductor wire. This single-wire induction (or ISU: induction par spire unique) makes it possible, if the conductor wire is suitably earth-insulated, to make protective transformers ensuring the power transmission between the levels situated at different potentials. The ISU technique extends to the design of very high dc voltages (up to 600 kV at least) obtained by feeding by means of this method, series-connected modular stages. The calculation factors relating to a three-staged model supplying 10 mA at 45 kV, are described, as well as various possible extensions of the process. (France)

38022 USKORITELI. VYPUSK XI. (Accelerators. Issue 11). Val'dner, O. A. (ed.). Moscow; Atomizdat (1969). 208p.

Thirty-one articles are included on the theory and development of high-current linear accelerators for low energies. Bunching calculations are given, and the transverse instability of a beam of electrons is examined. Certain theoretical aspects of the electrodynamic separation of highly relativistic particles, such as those obtained from a synchrophasotron, are treated. Experimental results on the high-frequency characteristics of accelerating systems of electron linear accelerators and wave guides used in beam separators are presented. Calculations for the accelerating sections of a 1000-GeV cybernetic accelerator are also presented. (tr-auth)

38023 GATED ION SOURCE FOR CYCLOTRON OPERATION AT REDUCED BEAM REPETITION RATES. Bentley, R. F.; Erb, L. A.; Lind, D. A.; Zafiratos, C. D.; Zaidins, C. S. (Univ. of Colorado, Boulder). Nucl. Instrum. Methods; 83: 245-53 (1970).

A method of reducing the repetition rate of cyclotron beam bursts for time-of-flight work is presented. By use of a pulsed gate electrode at the ion source aperture, single beam bursts are admitted into the dee at a frequency between $\frac{1}{3}$ and $\frac{1}{30}$ of the cyclotron frequency. Advantages of this method over external beam deflection include decreased dee loading, decreased background radiation, decreased power requirements, and an unambiguous ability to identify single-turn extraction. This latter feature gives the narrowest possible burst widths and hence has the best possible time resolution. The ability to identify single-turn extraction also has far-reaching implications in improving cyclotron operation particularly with regard to high energy resolution. (auth)

38024 PROPOSAL FOR AN ION OPTICAL CONDENSOR STRUCTURE. Wollnik, H. (Justus-Liebig Univ., Giessen, Ger.). Nucl. Instrum. Methods; 83: 229-31(1970).

The proposed condensor structure consists of two charged particle lenses of short focal length. The purpose of this structure is to effectively increase the number of usable secondary particles created in reactions with charged primary particles. One of these lenses is used for the "illumination" of a spot of the target by charged particles. The other causes a larger percentage of charged reaction products to enter the limited aperture of a particle detector or spectrometer. Thus the number of finally registered particles in many cases can be increased without a deterioration of the experiment. (auth)

38025 THIRD-ORDER ABERRATIONS OF A MAGNETIC QUADRUPOLE LENS. Lee-Whiting, G. E. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Nucl. Instrum. Methods; 83: 232-44(1970).

General expressions for the aberration coefficients are derived in a form in which derivatives of the magnetic gradient do not appear. Specializations to a segment of the optic axis on which the gradient is uniform and to the rectangular model are given. A segment on which the gradient varies is treated by expansion in a power series; the expansion coefficients depend on form-factors similar to those occurring in the first-order theory. Momentum-dependent aberrations and the transit-time are handled in the same way. In all cases laws are given for combining the effects of two adjacent segments. The calculations do not support the idea that hyperboloidal pole-ends result in reduced aberrations. (auth)

38026 POLARIZED PROTON TARGET FOR LOW ENERGY n–p SCATTERING. Bendt, P. J.; Jackson, J. A.; Martin, J. C.; Roberts, T. R.; Simmons, J. E. (Los Alamos Scientific Lab., N. Mex.). Nucl. Instrum. Methods; 83: 201-7(1970).

A polarized proton target of lanthanum magnesium nitrate is described, which was used to measure the spin correlation function C_{NN} got n-p scattering at 23 MeV. Also described are problems associated with low energy scattering experiments, which determined the design of the microwave cavity, NMR coil, and window for recoil protons. The factors determining target polarization are discussed, as well as improvements that were made to increase the polarization to the 60-70% range. The cryostat, microwave, and NMR systems are described. Further improvements are suggested, which would make the target more convenient to use. (auth)

38027 CYCLOTRON BEAM CURRENT LIMITS BASED ON RESIDUAL RADIATION. Fulmer, C. B.; Ball, J. B.; Lord, R. S.; Livingston, R. S. (Oak Ridge National Lab., Tenn.). Nucl. Instrum. Methods; 83: 193-6(1970).

Beam current limits, based on residual radiation levels, were determined for protons, deuterons, helium-3, and alpha particle beams in the Oak Ridge Isochronous Cyclotron. The basis for setting the limits is that the radiation level, due to radioactivity induced by beam loss in the extraction system, should be the same

after sixteen hours' cooling for the various particle types and range of energy. The energies extend to 40 MeV for deuterons, 65 MeV for protons, and 80 MeV for helium-3 and alpha particles. All of the significant radioactivities were taken into account. Excitation functions, based on experimental data, were used. A computer program was used to perform the residual radiation calculations. Maximum permissible beam losses were thus determined for the present ORIC extraction system, which consists of components of carbon, aluminium, copper, and tantalum. The effects on the beam current limits of variation of cooling times and bombardment times were also explored. Similar calculations were made for an all copper extraction system. Calculated residual radiation levels are compared with experimental measurements. (auth)

38028 SPILL SERVO CORRECTION SYSTEM FOR HIGH ENERGY BEAMS. Aitken, T. W.; Suller, V. P. (Nuclear Physics Lab., Daresbury, Eng.). Nucl. Instrum. Methods; 83: 176-80(1970).

A servo system which controls the rate of bremsstrahlung production from the internal targets of the electron synchrotron NINA is described. Very uniform bremsstrahlung spills of 2.5 ms duration are produced. Complete stability is achieved by using a specially constructed hundred channel sample-and-hold device which effectively removes servo delays and enables very strong feedback to be used. (auth)

38029 POSITIVE ION CAMERA FOR BLOCKING AND CHANNELING STUDIES. Engelmohr, G. O.; Mueller, R. M.; White, W. (Nuclear-Chicago Corp., Des Plaines, Ill.). Nucl. Instrum. Methods; 83: 160-4(1970).

A camera designed for studies of the spatial distributions of heavy charged particles scattered from crystals is described. The system includes a 2-axis goniometer with translational motions for sample manipulation, a vacuum lock for rapid film insertion, and a fluorescent screen to aid in crystal alignment. Externally selectable collimators have been placed in a drift tube section separate from the electrically insulated scattering chamber. The chamber thus becomes a Faraday cup, an arrangement which facilitates current and charge measurements. Either transmission or back reflection measurements can be carried out in the design energy range of 10 keV to 2 MeV for ^{1}H and ^{4}He particles. (auth)

38030 FORMATION OF UNIFORM DOSE FIELDS OF HIGH-ENERGY BREMSSTRAHLUNG BY MEANS OF "EQUALIZING" TARGETS. Kovalev, V. P.; Kharin, V. P.; Gordeev, V. V.; Filipenok, S. P. (Inst. of Medical Radiology, Erevan). Med. Radiol.; 15: No. 5, 49-54(May 1970). (In Russian).

The results of experimental studies of angular distributions of bremsstrahlung and neutron radiation for targets from copper which was selected as a model material are depicted. In alteration of the form of the target there is seen a distinct effect of equalization of the field of bremsstrahlung. Results of experimental verification of the influence of the factor of accumulation on the dose value for a combination of copper target and aluminum filter are presented. The experimental results of measurement of angular distributions of neutrons are in accordance with the theory of photoneutron reactions. The effect of the form of the target on the angular distribution of neutrons is demonstrated. (auth)

38031 ANALYSIS OF ISOCHRONOUS CYCLOTRONS WITH SEPARATED HARD-EDGE MAGNETS. Gordon, M. M. (Michigan State Univ., East Lansing). Nucl. Instrum. Methods; 83: 267-71(1970).

The orbit properties of isochronous cyclotrons with separated magnets are analyzed on the basis of the hard-edge approximation. This analysis extends previous work by treating magnets having a quite general shape. This treatment results in a generalized expression for the field index. A computer program ("Spyring Code") is described which uses this analysis to calculate orbit properties for a given magnet geometry. Results are presented for a 600 MeV cyclotron having a symmetric six sector geometry with a radially decreasing magnet fraction. These results demonstrate that this type of magnet geometry produces greater vertical focusing than a comparable design with a constant magnet fraction. (auth)

38032 USE OF ORIENTED LOW CARBON STEEL AS CORE MATERIAL OF GRADIENT MAGNETS FOR A STRONG FOCUSING PROTON SYNCHROTRON. Doke, T. (Tokyo Univ.); Hirose, T.; Kihara, M.; Sasaki, H.; Masuda, M. Nucl. Instrum. Methods; 83: 300-8(1970).

From the view-point of application to gradient magnets for a strong focusing proton synchrotron, the magnetic and mechanical properties of oriented low carbon steels as well as typical non-oriented low carbon steels are investigated in detail. One gradient magnet of non-oriented steel and two of oriented steel were constructed and the distributions of field gradient for these magnets were measured at various excitations. As a result of the measurements, it is shown that in the gradient magnet made of oriented steel the use of the field up to 17 kG is possible. Furthermore, the computer calculations of the field gradient distribution for gradient magnets of oriented steel were made by using the magnetic property in the direction perpendicular to the median plane of the magnet gap. The results are in fairly good agreement with those of the field measurements. (auth)

38033 METHOD FOR ADJUSTING ISOCHRONISM IN SEPARATED SECTOR ISOCHRONOUS CYCLOTRONS. Schatz, G. (Kernforschungszentrum, Karlsruhe, Ger.). Nucl. Instrum. Methods; 83: 326(1970).

A separated sector isochronous cyclotron is proposed which uses two different types of magnets for producing the guide field. By changing the ratio of the field in the different magnets, the radial field increase, required to maintain isochronism, can be adjusted independently of the mean field. (auth)

38034 SIMPLE TECHNIQUE FOR THE PREPARATION OF ^{12}C TARGETS. Kusuhara, M. (Tokoyo Inst. of Tech.). Nucl. Instrum. Methods; 83: 327(1970).

A simple method for producing uniform ^{12}C targets thicker than 15 mg/cm^2 is described. (auth)

38035 METHOD FOR THE PREPARATION OF DEUTERATED POLYETHYLENE TARGETS. Kusuhara, M. (Tokyo Inst. of Tech.). Nucl. Instrum. Methods; 83: 328(1970).

A simple method for the preparation of thin deuterated polyethylene films of optional size and thickness is described. (auth)

38036 NUCLEAR PHYSICS USING HEAVY IONS. 2. HEAVY ION ACCELERATION. Kono, Isao; Karasawa, Takashi (Inst. of Physical and Chemical Research, Yamato, Japan). Nippon Butsuri Gakkaishi; 24: 787-801(Dec 1969). (In Japanese).

The technical problems associated with heavy ion acceleration are discussed, together with the present state and future program of the research in this field in foreign countries. The production of heavy ions with multiple charges by means of arc discharge, atomic collision, laser radiation, nuclear fission, electron beam, and charge exchange in stripper gas, is reviewed. The acceleration of heavy ions using the tandem Van de Graaff accelerator, the heavy-ion cyclotron, the cyclotron of two-step type, and the linear accelerator is discussed. Plans are now in progress to accelerate the heavy ions up to uranium to energies higher than the Coulomb barrier, at Burlington, Oak Ridge, Argonne, Dubna, Orsay and Heidelberg. (NSA of Japan)

38037 CIRCULAR POLARIZATION OF HORIZONTAL HARMONICS IN A CYCLOTRON FIELD WITH A SLOWLY PERTURBED CYLINDRICAL SYMMETRY. Besnier, Gilbert (Rennes Univ., France). Compt. Rend., Ser. B; 270: 1265-8(20 May 1970). (In French).

A beam of charged particles was guided by a cyclotron field possessing weak azimuthal inhomogeneities. The conditions under which harmonics of the horizontal field become polarized were defined. A theoretical relation between the polarization of a horizontal harmonic and the radial gradient index number due to the field defect is derived. (France)

38038 EFFECT OF SHIELDING ON THE NEGATIVE MASS EFFECT. Ivanov, I. N. Sov. Phys.-Tech. Phys. (Engl. Transl.); 14: 732-5(Dec 1969).

Translated from Zh. Tekh. Fiz.; 39: 976-81(Jun 1969).

The influence of a conducting surface on the growth of an instability of the negative mass type is investigated using the example of an infinite hollow charged cylinder with an azimuthal current, surrounded by a metal shell. It is shown that shielding reduces the growth rate. (auth)

38039 ENERGY ANALYZER FOR CHARGED PARTICLES FOCUSED BY A LONGITUDINAL MAGNETIC FIELD. Kozlov, I. G.; Kabanov, L. N. (Saratov State Univ., USSR). Sov. Phys.-Tech. Phys. (Engl. Transl.); 14: 1280-2(Mar 1970).

Translated from Zh. Tekh. Fiz.; 39: 1706-9(Sep 1969).

The motion of particles in an axially symmetric magnetic field, the magnetic induction of which, beginning from the point $z = 0$, decreases in accordance with the equation $B(z,0) = B_0 e^{-kz}$, where k is a constant characterizing the rate of reduction of the fields is examined. Experiment shows that this exponential law of magnetic field variation may be generated on the axes of two solenoids placed in series, whose windings contain currents of different strength. (W.H.K.)

38040 UNDULATOR SYNCHROTRON. Fomenko, G. P.; Yushkov, Yu. G. Sov. Phys.-Tech. Phys. (Engl. Transl.); 14: 1243-6(Mar 1970).

Translated from Zh. Tekh. Fiz.; 39: 1658-63(Sep 1969).

The design and operation of a new type of accelerator which is expected to accelerate electrons to 5 or 10 MeV are described. Electrons emerging from the injector enter the resonator at the maximum of the H_{01M} standing-wave mode, which is excited in the resonator, receive an energy eV cos ϕ, and then enter a magnetic field. The electrons are deflected through a 180° angle in the magnetic field, again enter the resonator and are accelerated, then again enter a 180° deflecting field, etc. Stability conditions for phase oscillations and for betatron oscillations are found. (W.H.K.)

38041 EXCITATION OF HYBRID OSCILLATIONS OF A RELATIVISTIC ELECTRON BEAM IN AN IRIS-LOADED WAVEGUIDE. Grizhko, V. M.; Zykov, A. I.; Grishaev, I. A.; Kratskoi, G. D. (Physical-Technical Inst., Kharkov). Sov. Phys.-Tech. Phys. (Engl. Transl.); 14: 1234-6(Mar 1970).

Translated from Zh. Tekh. Fiz.; 39: 1646-9(Sep 1969).

Methods and results are given for measurements of hybrid EH_{11} modes excited by a relativistic electron beam in an iris-loaded waveguide in a linear accelerator. (auth)

38042 APPLICATION OF GAUSS BRACKETS TO CALCULATIONS INVOLVING DISPERSIVE ELECTRON-OPTICAL SYSTEMS. Chechulin, V. N.; Yavor, S. Ya. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Tech. Phys. (Engl. Transl.); 14: 1093-6 (Feb 1970).

Translated from Zh. Tekh. Fiz.; 39: 1457-62(Aug 1969).

A description is given of an application of the method of Gauss brackets to calculations involving dispersive electron-optical prisms. The elements of the Gauss brackets for sector magnets with uniform and non-uniform fields and the cylindrical condenser are calculated as an illustration of the method. (auth)

38043 BEAM FOCUSING BY AN ELECTROSTATIC MIRROR WITH A CYLINDRICAL FIELD. Zashkvara, V. V.; Redkin, V. S. (Inst. of Nuclear Physics, Alma-Ata, USSR). Sov. Phys.-Tech. Phys. (Engl. Transl.); 14: 1089-92(Feb 1970).

Translated from Zh. Tekh. Fiz.; 39: 1452-6(Aug 1969).

The conditions for improving the angular focusing of a beam of charged particles in a high-transmission electrostatic spectrometer with a cylindrical field are considered. (auth)

38044 DESIGN OF ELECTRON-OPTICAL QUADRUPOLE–OCTUPOLE CORRECTING LENSES. Shpak, E. V.; Yavor, S. Ya. Sov. Phys.-Tech. Phys. (Engl. Transl.); 14: 1297-1300(Mar 1970).

Translated from Zh. Tekh. Fiz.; 39: 1723-7(Sep 1969).

The conditions governing correction of third-order spherical aberration in electron-optics systems containing axisymmetric or cylindrical lenses, with the aid of quadrupole-octupole elements, are investigated. The short-lens approximation is utilized in the calculations. (auth)

38045 COMPUTER SOLUTION OF TWO-DIMENSIONAL NONLINEAR MAGNETOSTATIC PROBLEMS (STRONG-SATURATION CASE). Doinikov, N. I.; Simakov, A. S. Sov. Phys.-Tech. Phys. (Engl. Transl.); 14: 1097-1103(Feb 1970).

Translated from Zh. Tekh. Fiz.; 39: 1463-71(Aug 1969).

A method of numerical solution of two-dimensional nonlinear magnetostatic problems (plane-parallel and possessing rotational symmetry) is described; the essential idea is to replace the differential equation by a system of difference equations that relate the values of the vector potential at the points of a rectangular mesh. Stable convergence of the iteration process is achieved by carrying out successive superrelaxations in the entire domain (air, iron, and the internal boundaries). The dependence of the permeability on the induction at values exceeding 20 kG is taken into account. Calculations on the Minsk-2 and BESM-3M computers made in connection with the design of magnets for bubble chambers with fields of 25–30 kG are described. (auth)

38046 STABILITY OF A CYLINDRICAL ELECTRON LAYER IN A UNIFORM MAGNETIC FIELD SURROUNDED BY A METAL SHIELD. Ivanov, I. N.; Makhan'kov, V. G. Sov. Phys.-Tech. Phys. (Engl. Transl.); 14: 725-31(Dec 1969).

Translated from Zh. Tekh. Fiz.; 39: 965-75(Jun 1969).

A study was made of the stability of a thin cylindrical layer of electrons in a magnetic field inside a smooth waveguide (the wall conductivity is assumed to be infinite). It is shown that even in the linear approximation the presence of such a field significantly affects not only longitudinal instabilities of the negative-mass type, but also tranverse flute instabilities. Furthermore, in contrast to plane geometry, where the growth rate of the flute instabilities is increased by the presence of a shield in a cylindrical layer, the shield eliminates the instability. (auth)

38047 DIVERGENCE OF ION BEAMS WITH FINITE PHASE VOLUME. Vecheslavov, V. V.; Kononov, V. I. Sov. Phys.-Tech. Phys. (Engl. Transl.); 14: 702-3(Nov 1969).

Translated from Zh. Tekh. Fiz.; 39: 938-40(May 1969).

The motion of an ion beam in a region free of external fields, governed both by the Coulomb repulsive forces and by the randon thermal spread in the transverse velocity of the particles, is studied. A measure of this spread, the phase volume occupied by the beam particles in transverse phase space, is discussed. (W.H.K.)

38048 POLARIZED NEGATIVE DEUTERON INJECTOR FOR A TANDEM ACCELERATOR. Slabospitskii, R. P.; Kiselev, I. E.; Karnaukhov, I. M.; Lopatko, I. D.; Taranov, A. Ya. (Physical-Technical Inst., Kharkov). Sov. Phys.-Tech. Phys. (Engl. Transl.); 14: 1129-33(Feb 1970).

Translated from Zh. Tekh. Fiz.; 39: 1506-12(Aug 1969).

A description is given of an injector of polarized negative deuterium ions for a tandem accelerator. The injector consists of a source of polarized positive ions in which an atomic beam is focused by a strong inhomogeneous magnetic field; the beam is then ionized by electrons in a uniform magnetic field. The polarized negative ions are converted into positive ions in a supersonic jet of mercury vapor. The post-acceleration polarization of the deuterium beam is $P_{33} = -0.290 \pm 0.017$. The intensity of the accelerated beam of polarized ions beyond an aperture 0.3 cm in diameter is $1.2 \cdot 10^9$ ions/sec. (auth)

38049 DESIGN PARAMETERS OF AN ION–OPTICAL SYSTEM FOR TRANSPORT AND ANALYSIS OF A BEAM EXTRACTED FROM THE 240-CENTIMETER ISOCHRONOUS CYCLOTRON. Basargin, Yu. C.; Korolev, L. E. Sov. Phys.-Tech. Phys. (Engl. Transl.); 14: 1109-14(Feb 1970).

Translated from Zh. Tekh. Fiz.; 39: 1478-85(Aug 1969).

The general arrangement for the transport and analysis of a beam from the 240-cm cyclotron is described. The magnetooptical system makes it possible either to direct beams of high-energy resolution onto a target or to achieve achromatic transport. The capabilities of the ion optics are discussed from the viewpoint of the effect on beam microstructure in time. (auth)

38050 MAGNETIC SYSTEM OF A LARGE CHARGED-PARTICLE SPECTROMETER. Basargin, Yu. G.; Doinikov, N. I.; Popov, A. V.; Rozhdestvenskii, B. V.; Samsonov, G. N.; Simakov, A. S. Sov. Phys.-Tech. Phys. (Engl. Transl.); 14: 1104-8 (Feb 1970).

Translated from Zh. Tekh. Fiz.; 39: 1472-7(Aug 1969).

The design of a magnetic analyzer with an inhomogeneous field is given. The angle of curvature is 270° at a radius of 2 m. If $n = 0.831$, double focussing and high resolution are obtained; at $n = 0.169$ the correlations for triple focussing are satisfied. The magnitude of n is varied by a special quadrupole winding. Aberration is corrected by regulated nonlinear lenses. Results of computer calculations of the field distributions in the gaps of the main and correcting magnets are presented. Structural features of the magnetic system are discussed. (auth)

38051 DOUBLE-FOCUS PLASMA ION–OPTICAL SYSTEMS. Morozov, A. I. Sov. Phys.-Tech. Phys. (Engl. Transl.); 14: 645-6(Nov 1969).

Translated from Zh. Tekh. Fiz.; 39: 862-4(May 1969).

Electromagnetic plasma ion-optical systems where (if the electron temperature is negligible) the potential distribution in the beam is given by $\Phi = \Phi(\gamma)$, where γ is the index of the magnetic line of force are studied. It is shown that axially symmetric systems with closed drift and double focusing do not exist if $\Phi = \Phi(\gamma)$ holds and the basic trajectory coincides with the symmetry axis. (W.H.K.)

38052 MEASUREMENT OF THE PHASE SPECTRUM OF ACCELERATED ELECTRONS USING A HIGH-FREQUENCY SEPARATOR. Zykov, A. I.; Kramskoi, G. D.; Ostrovskii, E. K. (Physical-Technical Inst., Kharkov). Sov. Phys.-Tech. Phys. (Engl. Transl.); 14: 756-8(Dec 1969).

Translated from Zh. Tekh. Fiz.; 39: 1007-10(Jun 1969).

A method of measuring the phase distribution of electrons at the exit of an ejector accelerator is described and the results of the measurements are given. For a beam energy of 6 MeV, a separator length of 40 cm, and 16 MW high-frequency power input to the separator, the phase resolution of the unit is to ±0.5°. (auth)

38053 HYBRID APPROACH TO A UNIVERSAL MATHEMATICAL MODEL SIMULATING PARTICLE TRAJECTORIES AND

THEIR ENVELOPE IN AN ACCELERATOR. Willems, Carl (Electronic Associates Inc., Brussels). pp 36-40 of Analog and Hybrid Computation Applied to Nuclear Energy. Brussels, Presses Academiques Europeennes (1969). (In French).

From International Symposium on Analogue and Hybrid Computation Applied to Nuclear Energy, Versailles, France. See CONF-680941.

The systematization and automation of a family of problems related to experiments carried out using a large particle accelerator are considered. These attempts were carried out on a hybrid system EAI 690 at the Centre Europeien de Calcul-de Bruxelles. The physical structure of the accelerator is made of a combination of three basic elements in which the lateral and vertical deflection of the particles are studied and described by various simple second-order rules. These are the deflector magnets, accelerator magnets, and vacuum zones. It is interesting to follow the particle trajectory in the electromagnetic fields thus generated, and to analyze the effects of their injection conditions. One can find in the same direct manner the envelopes of the trajectories in question by solving the differential equations related to those describing the individual trajectories. The contribution of the hybrid calculation consists in using conjointly the advantages of the analogous calculation for the continued solution of the differential equations and those of the numerical calculation. To assure efficient management of this calculation, numerous changes must be accounted for and brought into agreement with the constituent elements of the physical system. The retained solution, which will be annotated during the exposition, consists of making a table the data of which are accumulated in the memory of a computer. Each line of this table describes a constituent element of the physical system; each column compiles a specific parameter of the element (type of element—accelerator or deflector, etc.). Another program assures the management of this table to solve the case of a given illustration. It uses the command interface for commutation functions and control of the operation mode of the analog integrators, and also the interface for the exchange of data for the precise and efficient rapid injection of parameters which vary from one element to the next. Another refinement of this model permits modifying by a potentiometer certain significant parameters of the experiment by varying remotely and by analog means the contents of the numerical table. Finally, the technique of repetitive analog calculation permits the experiments to be visualized very quickly and to realize the effect of each parameter on the expected results. (tr-auth)

38054 OPERATIONAL RESULTS WITH THE 1.5 GeV SYNCHROTRON AT THE TOMSK POLYTECHNICAL INSTITUTE. Vizir, V. A.; Krasnonosen'kikh, P. P.; Lashuk, N. A.; Chuchalin, I. P.; Shchanin, P. M. Sov. Phys.-Tech. Phys. (Engl. Transl.); 14: 736-40(Dec 1969).

Translated from Zh. Tekh. Fiz.; 39: 982-7(Jun 1969).

A report is given on start-up and operation of the synchroton. The injection system and measurements of the electron beam are described. Experimental relationships are given between the trapping at the first stage of injection and the injection time; the relation between intensity and initial accelerating voltage, the rf switching time and the relaxation time of the rf field in the cavity is also established. Data are also given on the interaction between the second unenergized cavity and the accelerated electron beam. (auth)

PHYSICS (NUCLEAR)

Neutron Interactions with Matter

Refer also to abstracts 36653, 37555, and 38148.

38055 (AERE-R-4920) NOTES ON THE DESIGN OF MULTISLOTTED ROTORS FOR NEUTRON VELOCITY SELECTORS. Cocking, S. J. (Atomic Energy Research Establishment, Harwell (England)). Apr 1970. 26p. Dep. CFSTI (U. S. Sales Only). UK 4s. 0d.

The curvature required by the slots of multislot rotors in order that each passes the same mean neutron velocity is calculated. The effect of small deviations from the best shape is emphasized and illustrated with experimental results. Expressions for the resolution in time and neutron velocity passed by single and phased rotor systems are obtained. The principal stresses in a rotating multislot rotor are identified and simple expressions to estimate their magnitudes are given. (auth) (UK)

38056 (AI-AEC-MEMO-12915) THE EVALUATION OF SEVERAL ENDF/B NUCLIDE CROSS-SECTIONS BY A MONTE CARLO TECHNIQUE. Dunford, C. L.; Alter, H. (Atomics International, Canoga Park, Calif.). 15 Jan 1970. Contract AT(04-3)-701. 28p. Dep. CFSTI.

The Monte Carlo code TYCHE IV was used to calculate with a high degree of convergence the second, fourth, and sixth spatial moments of the slowing-down density distribution at the indium resonance energy, for neutrons originating from a fission source at a point in infinitely extended light water, heavy water, graphite, aluminum/water, iron/water and zirconium/water moderators. These calculations, the results of which are compared with integral experiments, were done in support of the Phase-II data testing effort for the ENDF/B neutron cross-section files. (auth)

38057 (BNWL-1312) EVALUATED REFERENCE CROSS SECTION LIBRARY. Simons, R. L.; McElroy, W. N. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). May 1970. Contract AT(45-1)-1830. 105p. Dep. CFSTI.

This library of energy-dependent neutron-reaction cross sections exists for use in calculating the integral fluxes and fluences of fast and thermal test reactor environments. Calculations employing these cross sections are used in the analysis of irradiation tests of structural and fuel cladding material for the Liquid Metal Fast Breeder Reactor (LMFBR) Program. Recent evaluations of cross sections contained in this library and of uncataloged cross sections were used to update the library to achieve greater consistency and accuracy. The consistency of the 23 new and revised cross sections was shown by comparing calculated 2200 m/sec cross sections, resonance integrals, and fission-averaged cross sections with measured values and/or previously reported calculated values. (auth)

38058 (EUR-4455) MEASUREMENTS OF THE SCATTERING CROSS SECTIONS OF LIQUID AND SOLID HYDROGEN, DEUTERIUM HYDRIDE FOR THERMAL NEUTRONS. Seiffert, W.-D. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). 30 Oct 1969. 36p. (In German). Dep. CFSTI (U. S. Sales Only). DM 3,70.

Measurements of the scattering cross sections for thermal neutrons (2 to 80 MeV) of liquid and solid normal-H_2, para-H_2, D_2, and HD are presented. The scattering by liquid para-H_2 and HD shows clearly coherent features. The cross sections of liquid and solid para-H_2 and HD show the onset of inelastic scattering with excitation of the first rotational level. The measured cross sections are compared with numerical calculations. (auth)

38059 (GA-10060) INTEGRAL NEUTRON THERMALIZATION. Quarterly Progress Report, January 1–March 31, 1970. Slaggie, E. L.; Borgonovi, G. M.; Houston, D. H.; Neill, J. M. (Gulf General Atomic, Inc., San Diego, Calif.). 7 Apr 1970. Contract AT(04-3)-167. 18p. Dep. CFSTI.

Research progress on the integral neutron thermalization program during the period Jan. 1, 1970 to March 31, 1970, is described. The work included improvements to the FLANGE II code, energy mesh selection for thermal group-averaging, thermal benchmark calculations, and ENDF related activities. (J.W.R.)

38060 (IJS-574) CONSTRUCTION AND PERFORMANCE OF THE LIQUID METHANE COLD SOURCE. Dimic, V.; Petkovsek, J. (Institut Jozef Stefan, Ljubljana (Yugoslavia)). Jan 1970. 11p. Dep. CFSTI (U. S. Sales Only).

A liquid methane cold source was installed in one of the tangential beam tubes of the reactor TRIGA Mark II at the Institute "Jozef Stefan." The design and construction of the cooling system and cold source assembly is outlined in detail. With a source such as described, a reliable and continuous operation can be achieved. (auth)

38061 (LA-4095) NEUTRON FLUX DETERMINATION IN TIME-OF-FLIGHT CROSS-SECTION MEASUREMENTS USING UNDERGROUND NUCLEAR EXPLOSIONS. Brown, W. K.; Seeger, P. A.; Silbert, M. G. (Los Alamos Scientific Lab., N. Mex.). 20 May 1969. Contract W-7405-eng-36. 17p. Dep. CFSTI.

Time-of-flight measurements of neutron cross sections involve determination of the neutron-beam flux by use of various flux monitors. The unique features of the Los Alamos Scientific Laboratory explosion-source measurements have necessitated development of special instruments and methods for the flux determination for each type of reaction studied. General measurement techniques and neutron-beam flux characteristics are reviewed. Properties of flux monitors for fission, capture, and scattering and for low neutron energies are discussed, as well as total cross-section measurement by transmission. Computer programs for data reduction are outlined, and the scheme for handling the propagation of errors is presented. (auth)

38062 (RT/FI-(69)42) THE CIAP-0 PROGRAM. Cecchini, G. P.; Cosimi, M. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 25 Sep 1969. 19p. Dep. CFSTI (U. S. Sales Only).

The CIAP-0 program calculates real and adjoint fluxes for a given composition, on the basis of the multigroup zero-dimensional diffusion theory, as well as real and adjoint generalized importances related to a linear or bilinear functional of the real or adjoint fluxes. By means of these fluxes and importances, the program can calculate any variation of the functional considered, in the generalized perturbation theory approximation. (auth)

38063 (SC-T-70-4021) PULSED NEUTRON GENERATOR FOR REACTOR-PHYSICS RESEARCH. Szabo, Z.; Dekany, I. Translated for Sandia Labs., Albuquerque, N. Mex., from KFKI (Kozp. Fiz. Kut. Intez.) Kozlem.; 17: No. 1, 3-19(1969). 22p. Dep. CFSTI.

A D-T neutron generator (NIG-200) was developed and built for use in making multiplier-system measurements. The current at the target during a pulse was 5 mA, the pulse length between 10 μs and 1 ms, the repetition frequency 0.1-2000 Hz, the maximum space factor 2%. The accelerator tube could be set at any angle between vertical and horizontal in its own plane, and the height of the rotation axis could be varied between 0.9 and 2.0 m. The 200-kV accelerating potential was obtained with a split-core transformer. (auth)

38064 (SRARI-P-57) APPLICATION OF THE METHOD OF INTEGRAL TRANSFORMATIONS TO THE SOLUTION OF BOUNDARY PROBLEMS OF THE NEUTRON TRANSPORT THEORY. Ershov, Yu. I.; Shikhov, S. B. (Scientific Research Atomic Reactor Inst., Melekess (USSR)). 1969. 39p. (In Russian). Dep. CFSTI (U. S. Sales Only).

A method of solution of the neutron transport integral equation based on the application of integral transformations is considered. Radon and Fourier integral transformations are shown to be a convenient technique for the investigation of the neutron transport equation in arbitrary geometry. The method is illustrated on a cylindrical geometry example. Known Case's method results in plane and spherical geometries are shown to be obtained easily from the general scheme. Moreover, the possibility of taking account of scattering anisotropy in the limits of method is shown by the example of linear dependence of scattering indicatrix on angles. (auth)

38065 (URR-1) CONSTRUCTION AND PERFORMANCE OF A GLASS NEUTRON GUIDE. Bates, J. C. (Universities Research Reactor, Risley (England)). Jan 1970. 21p. Dep. CFSTI (U. S. Sales Only).

A 10 m long glass walled neutron guide with a radius of curvature of 300 m was constructed and tested. The dimensions and curvature were chosen so that neutrons could not reach the exit directly and only those striking the walls at less than their critical angle for total reflection were transmitted. Measurements of the input and output neutron intensities and spectra, and the variation of intensity and wavelength spectrum over the exit aperture confirmed the correct functioning of the guide. (auth) (UK)

38066 (WANL-TME-1982) USER'S MANUAL FOR THE DOT-IIW DISCRETE ORDINATES TRANSPORT COMPUTER CODE. Soltesz, R. G.; Disney, R. K.; Collier, G. (Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.). Dec 1969. Subcontract NP-1. 162p. Dep. CFSTI.

The WANL version of the DOT computer code for solving the two-dimensional, energy-dependent, linear Boltzmann transport equation with general anisotropic scattering is described. The major improvements of the DOT-IIW code over the DOT code are the inclusion of acceleration techniques on the group flux solution, improved convergence logic, asymmetric quadrature capability, and improved tape operations. Detailed user information involving problem setup, running time, quadrature data and mesh spacing requirements is described. In addition, requirements for eigenvalue, fixed volume distributed source, boundary source, and search calculations are given. Typical problem setup information is supplied as well as a description of the printed output. A sample problem card input and printout are included. (auth)

38067 (WAPD-TM-822(Add.1)) EPOCH: A PROGRAM TO CALCULATE NEUTRON AGES USING THE ENDF/B LIBRARY. Butler, J. D.; Gelbard, E. M.; Schmidt, E. (Bettis Atomic Power Lab., Pittsburgh, Pa.). May 1970. Contract AT-11-1-GEN-14. 25p. Dep. CFSTI.

EPOCH (BD05) is an extension of the programs originally described in WAPD-TM-822. It obtains nuclear cross sections from the ENDF/B Library and determines fine detail P-1 flux spectra for simply buckled media using up to 2000 lethargy groups. Neutron flux ages are computed from multiple spectra calculations by varying the buckling. The program ignores the ENDF/B resonance files since the number of groups required to accurately describe the cross section shapes in the resonant range becomes impractical for an analytic program. Thus EPOCH is most useful for higher energies and where resonant reactions are weak or absent. (auth)

38068 DIAMAGNETIC SCATTERING OF SLOW NEUTRONS. Stassis, C. (Massachusetts Inst. of Tech., Cambridge). Phys. Rev. Lett.; 24: 1415-16(22 Jun 1970).

Scattering of slow neutrons by the diamagnetic currents induced in an atom by an external magnetic field is investigated. The angular dependence of the diamagnetic scattering amplitude is given by $q^{-1}[df(q)/dq]$ where q is the magnitude of the scattering vector and f(q) the charge form factor of the atom. (auth)

38069 SENSITIVITY OF SECONDARY GAMMA-RAY DOSE TO ANGULAR DISTRIBUTION OF GAMMA RAYS FROM NEUTRON INELASTIC SCATTERING. Straker, E. A. (Oak Ridge National Lab., Tenn.). Nucl. Sci. Eng.; 41: 147-8(Jul 1970).

The secondary gamma-ray dose due to a 12.2- to 15-MeV neutron source in air was calculated as a function of range for three assumptions for the angle of emission of the gamma rays: isotropic emission, straight-ahead emission, and backward emission. The results showed a maximum difference of a factor of 2.5 at 1400 m, indicating that isotropic emission should be a good approximation for one-dimensional transport problems. (D.L.C.)

38070 SUM RULE FOR INTERFERENCE SCATTERING FROM A RIGID ROTOR. Lurie, N. A. (Univ. of Missouri, Columbia); Carpenter, J. M. J. Chem. Phys.; 52: 5967-8(1 Jun 1970).

The first frequency moment $\langle\omega^1\rangle$ of the slow neutron scattering law is evaluated without approximation for the case of the rigid diatomic molecule. The interference contribution ($\nu \neq \mu$) approaches an oscillating function of amplitude for large κ and is negligible compared to the direct terms. The equation results are compared with precise quantum-mechanical calculations for HCl and N_2, and good agreement is found. (D.L.C.)

38071 NEUTRON TRANSPORT IN A SLAB WITH LINEARLY ANISOTROPIC SCATTERING. Mai, W. (VEB Kombinat Kraftwerksanlagenbau, Berlin). Kernenergie; 13: 75-80(Mar 1970). (In German).

The Fourier transform method proposed by Kiesewetter is applied to the neutron transport problem in a slab with linearly anisotropic scattering. The eigenvalues and eigenfunctions are completely given. The system of eigenfunctions distinguishes from that of the trigonometric functions but near the boundary. (auth)

38072 DIFFUSION PARAMETERS FOR OM 1 AT DIFFERENT TEMPERATURES. Fleck, Carl M.; Hinke, Horst H. (Oesterreichische Hochschule, Vienna). Atomkernenergie; 15: 289-92 (1970).

Values of diffusion parameters for thermal neutrons for OM 1 (a mixture of o-, m- and p-terphenyl) have been obtained by the pulsed neutron source technique in the temperature range from 20 to 176°C, thus covering the solid and the liquid state. At low values of fundamental buckling B_f^2, approximate values of D_0 were also found by detecting both the fundamental and first axial mode of decay. Therefore it was unnecessary to perform a complete series of measurement. The measured temperature dependence of D_0 originates predominantly in the shift of the Maxwellian and a lowering of density. The assumption $\lambda_{tr}(E) \propto \sqrt{E}$ is well justified. A discontinuity of D_0 at the melting point (49°C) was found where the change in D_0 is quite large being of the same order as for diphenyl contrary to Hofmeyer's prediction. (auth)

38073 FINITE-SAMPLE CORRECTIONS TO NEUTRON SCATTERING DATA. Kinney, W. E. (Oak Ridge National Lab., Tenn.). Nucl. Instrum. Methods; 83: 15-28(1970).

The correction of neutron-scattering data for finite-sample effects in solid cylindrical samples up to 0.5 total mean free path in radius with height-to-diameter ratios of from 1 to 3 is described. Neutron attenuation is well approximated by assuming the sample to be a disk with the neutrons incident edge-on in a parallel beam. Angular spread is corrected by a factor obtained by numerical integration of the single-scattering integral. Multiple scattering is corrected by a combination of Monte Carlo results and traditional analytic methods, the energy change in inelastic scattering being included explicitly in the formulation. The effect of anisotropic scattering is shown to amount to a few percent at most and to lie within the errors introduced by the assumptions. The Monte Carlo calculations and the validity of the assumptions are considered in an appendix. (auth)

38074 SLOW NEUTRON SCATTERING IN THE LOW TEMPERATURE PHASE OF SOLID METHANE. Kapulla, H.; Glaeser, W. (Kernforschungszentrum, Karlsruhe, Ger.). Phys. Lett.; 31A: 158-9(23 Feb 1970).

Inelastic neutron scattering in solid methane at 4.4°K and at 19°K was investigated. At 4.4°K (γ-phase) an excitation mode with $\hbar\omega = 1$ MeV was observed which did not appear at 19°K (β-phase). (auth)

38075 NEUTRON SPECTRUM OF A ^{241}Am–Be(α,n) SOURCE AS SIMULATED BY ACCELERATOR PRODUCED α-PARTICLES. Geiger, K. W.; Van Der Zwan, L. (National Research Council, Ottawa). Int. J. Appl. Radiat. Isotop.; 21: 193-8(Apr 1970).

A thick Be target was irradiated with a 5.48 MeV α-beam. Neutron spectra were taken with a stilbene spectrometer at 15° intervals. After appropriate weighting and summation the simulated Am–Be source spectrum was obtained. This spectrum is compared with the spectrum obtained directly from a source and with spectra published by other authors. (auth) (UK)

Nuclear Properties and Reactions, A≤ 5

Refer also to abstracts 37934 and 38056.

38076 (BMBW-FBK-70-2) LOW LYING STATES OF LIGHT ATOMIC NUCLEI IN THE FRAMEWORK OF THE CLUSTER MODEL. Wodsak, W. (Tuebingen Univ. (West Germany). Institut fuer Theoretische Physik). Feb 1970. 114p. (In German). Dep. CFSTI (U. S. Sales Only). ZAED DM 23.95.

Different types are discussed for the Jastrow factor of the wavefunction which is necessary for calculations with realistic potentials, and they are investigated exactly and approximately. The ground states of ^{3}H and ^{3}He are calculated with a realistic potential containing tensor forces, using the Ritz variational method. The nuclei ^{2}H, ^{3}H, ^{3}He, ^{4}He are described by 2-6 wavefunctions of spatial symmetry. The lowest states of ^{6}Li are calculated by a superposition of (^{4}He, ^{2}H) and (^{3}He, ^{3}H) cluster model wavefunctions in a pure central potential. (auth)

38077 (ITF-70-25) CORRECTION TO THE VARIATIONAL CALCULATION OF THE GROUND STATE ENERGY ^{3}H. Maksimenko, V. N. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1970. 10p. (In Russian). Dep. CFSTI (U. S. Sales Only).

The correction of the second order of perturbation theory to the variational binding energy of nucleus ^{3}H conditioned by the difference of the pair interaction potential between nucleons from the effective potential generating the basic wave functions is considered. The general expression for such a correction in the case when the central and tensor forces act between nucleons is obtained. As test functions those of the harmonic oscillator were chosen. The numerical calculations for various potentials of the Gauss shape based on the data of the two-body problem were carried out. (auth)

38078 (RLO-1388-566) HIGH ENERGY NEUTRON-LIQUID ^{4}He SCATTERING AND THE ^{4}He CONDENSATE DENSITY. Puff, R. D.; Tenn, J. S. (Washington Univ., Seattle. Dept. of Physics). [1969]. 22p. Dep. CFSTI.

A simple theory of high-energy neutron scattering from liquid

^{4}He is developed. The inelastic scattering cross section for this process is related, for sufficiently high momentum transfer, to two parameters characterizing the ^{4}He momentum distribution. These two parameters are the average kinetic energy per particle and the fraction of particles in the zero momentum condensate. Comparison of the theory with recent experimental data indicates that ρ_0/ρ, the condensate fraction, is approximately 0.06 at T = 1.27°K. (auth)

38079 (RLO-1388-575) THE ^{3}He–^{3}H CHARGE FORM FACTOR AND THE ^{3}He COULOMB ENERGY. Friar, J. L. (Washington Univ., Seattle). Nov 1969. 19p. Dep. CFSTI.

A formula for the Coulomb energy difference of ^{3}He and ^{3}H is derived on the assumption that the trinucleon S-state wave function and the symmetric part of the S'- and D-state wave functions can be represented as a linear superposition of Gaussians. The formula contains only experimentally measured quantities, since the nuclear physics can be parametrized directly in terms of the observed ^{3}He and ^{3}H charge form factors. The result for the Coulomb energy difference is 0.64 ± 0.01 MeV. (auth)

38080 ELASTIC SCATTERING OF 28 MeV NEUTRONS BY DEUTERONS. Gouanere, M.; Chemarin, M.; Nicolai, G.; Burq, J-P. (Univ., Lyon). Nucl. Phys.; A144: 607-16(1970).

The differential cross section for the elastic scattering of neutrons by deuterons was measured at a neutron energy of 28 MeV. The data cover the c.m. scattering angles from 58 to 114° where the time-of-flight of the scattered neutron, the energy of the neutron deposited in the detector and the energy of the recoil deuteron were measured by using a three-parameter computer analysis. Another set of data covers the angles from 150 to 180° where the deuterons were detected in a E–dE/dx telescope. The data were normalized to the n-p scattering cross sections. (auth)

38081 POLARIZATION AND ASYMMETRY IN THE ^{3}He(d,p)^{4}He REACTION. Khangulyan, V. A. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz.; 11: 967-76 (May 1970). (In Russian).

Phenomenological discussion of the polarization phenomena is given in terms of the invariant amplitudes. The polarization is calculated in the pole approximation with account of the interference with slow varying terms in the amplitude. It is compared with the experiment. The mechanism due to the triangle graph with the virtual d(d,p)t reaction is studied. (auth)

38082 ELASTIC NEUTRON–ALPHA SCATTERING ANALYSES. Arndt, Richard A.; Roper, L. David (Virginia Polytechnic Inst., Blacksburg). Phys. Rev., C; 1: 903-22(Mar 1970).

An energy-dependent phase-shift analysis of 0- to 20-MeV n-α scattering is attempted. Reasonable fits to the 0 to 16.4 data are obtained, but the rest of the data up to 20 MeV elude good fits. Single-energy analyses at energies where polarization data are available corroborate the energy-dependent analysis. The results differ from the Hoop–Barschall phases as follows: $P_{\frac{1}{2}}$ is larger between 3 and 10 MeV; $S_{\frac{1}{2}}$ and $P_{\frac{3}{2}}$ are larger between 10 and 16.4 MeV. (auth)

38083 SINGLET DEUTERON EMISSION IN A (^{3}He,d) REACTION DESCRIBED BY DISTORTED-WAVE BORN APPROXIMATION. Bohne, W.; Hagen, M.; Homeyer, H.; Lettau, H.; Maier, K. H.; Morgenstern, H.; Scheer, J. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Phys. Rev. Lett.; 24: 1028-31(4 May 1970).

Emission of singlet deuterons is observed in the reaction ^{10}B(^{3}He,d)^{11}C by studying neutron-proton correlations. The resulting angular distributions are very similar to those of triplet deuterons and can be described in distorted-wave Born approximation assuming the d to behave like a single particle. (auth)

38084 STUDY OF ^{3}He + ^{3}He ELASTIC SCATTERING AND THE NUCLEUS ^{6}Be. Jenkin, J. G.; Harrison, W. D.; Brown, Ronald E. (Univ. of Minnesota, Minneapolis). Phys. Rev., C; 1: 1622-7(May 1970).

Differential cross sections for ^{3}He + ^{3}He elastic scattering were measured at 18 angles from 12.5 to 45° (lab) at energies of 17.91, 20.00, 22.00, 24.00, 26.00, 28.00, and 30.00 MeV (lab). In addition, differential cross sections were measured at intermediate energies from 19.00 to 32.00 MeV (lab) at angles of 20, 28, 36, and 45° (lab). The relative standard deviations of the data are generally less than 2%, and there is an additional standard deviation in the cross-section scale of 3%. The measurements are compared with theoretical calculations using the resonating-group method in the one-channel approximation. A broad resonance in the $l = 3$ partial wave is predicted by the theory, and such a resonance was observed in the present experiment. Differences between theory and experiment can be qualitatively understood as being caused principally by omission in the theory of reaction channels and noncentral forces. The effect of radial distortion in resonating-group calculations for the ^{3}He + ^{3}He system was also investigated in an approximate manner. It is found that the effect can be quite significant for calculations of the energies of states in ^{6}Be below the ^{3}He + ^{3}He threshold. (auth)

38085 ELASTIC SCATTERING OF ^{3}He BY ^{4}He FROM 17.8 TO 30.0 MeV. Jacobs, C. G. Jr.; Brown, Ronald E. (Univ. of Minnesota, Minneapolis). Phys. Rev., C; 1: 1615-21(May 1970).

Differential cross sections for the elastic scattering of ^{3}He by ^{4}He were measured from 21.9 to 155.0° (c.m.) at ^{3}He energies of 17.79, 19.99, 22.00, 23.98, 26.00, 28.00, and 30.00 MeV (lab). The relative standard deviations of the data are typically less than 2.5%, but become larger at angles where the cross section is very low. In addition to relative errors, the over-all error includes a standard deviation of 3% in the cross-section scale. The measurements are compared with theoretical calculations using the resonating-group method in the one-channel approximation. Differences between theory and experiment can be qualitatively understood as being caused mainly by the omission of reaction channels in the theory. (auth)

38086 THREE-BODY PROBLEM WITH LOCAL HARD-CORE POTENTIAL. Kim, Y. E.; Tubis, A. (Purdue Univ., Lafayette, Ind.). Phys. Rev., C; 1: 1627-32(May 1970).

The Faddeev formalism is used to compute the ground-state energy of the triton for a simple model in which the nucleon–nucleon force is given by a spin-independent s-wave Herzfeld potential (hard core with outside square well). The effective nucleon–nucleon potential used corresponds to the usual weighted average of triplet and singlet potential strengths. The two-variable Faddeev equation is solved using the complete off-shell t matrix given by: (1) an exact analytic expression, and (2) an integral-equation formalism recently proposed. Three-body calculations based on both evaluations of the two-body t matrix lead to a triton binding energy of 8.13 MeV with about 0.5% accuracy. (auth)

38087 MEASUREMENT OF ANGULAR CORRELATIONS IN THE DECAY OF POLARIZED NEUTRONS. Christensen, C. J.; Krohn, V. E.; Ringo, G. R. (Argonne National Lab., Ill.). Phys. Rev., C; 1: 1693-8(May 1970).

The electron-momentum-neutron-spin correlation coefficient was found to be $A = -0.115 \pm 0.008$, and the antineutrino-momentum-neutron-spin correlation coefficient was found to be $B = 1.00 \pm 0.05$. The value of A leads to $|G_A/G_V| = 1.26 \pm 0.02$ for the ratio of Gamow-Teller to Fermi coupling constants in β decay, and B is consistent with zero scalar or tensor interaction. (auth)

38088 SEMIEMPIRICAL INTERPOLATION FORMULA FOR ELASTIC n-d SCATTERING. Ludin, R. I.; Wooten, B. A.; Goloskie, R.; LaMontagne, R. G. (Worcester Polytechnic Inst., Mass.). Phys. Rev., C; 1: 1740-2(May 1970).

The experimental n-d differential elastic-scattering cross section was fitted by a two-term, five-parameter analytic equation in the energy region 1-21 MeV. This equation resembles the direct and exchange terms resulting from a Born-approximation treatment. A least-squares method was utilized to fit this equation, to within 1%, to the tabulated cross sections of Horsley and Stewart. Smooth energy dependences, describable in simple functional forms, were found for the five parameters. The formula has been shown to interpolate well to fit new elastic-scattering data in this energy region. (auth)

38089 SEPARABLE POTENTIALS IN $\alpha-\alpha$ ELASTIC SCATTERING BELOW 30 MeV. Pigeon, J.; Barguil, J.; Fayard, C.; Lamot, G. H.; Elbaz, E. (Univ., Lyon). Nucl. Phys.; A145: 319-36(1970).

The use of non-local separable potentials leads to a simple analytical expression for the elastic scattering processes, even when the Coulomb effect is taken into account. The nuclear phase shift is given by an explicit formula identical to that for the neutral particle case, except that the separable potential is expressed in a (χ_k^-) representation. The formalism described was used in $\alpha-\alpha$ elastic scattering below 30 MeV. The parameters concerned were determined by comparison with experimental data, and close agreement with the experimental nuclear phase shift was obtained. (auth)

38090 A SHELL-MODEL CALCULATION FOR ^{5}He AND ^{5}Li. Ramavataram, K.; Ramavataram, S. (Laval Univ., Quebec). Nucl. Phys.; A147: 293-304(1970).

Shell-model calculations using the Kurath force and the Tabakin separable potential for the residual interactions have been performed to interpret the experimental data now available for the T = ½ states in ^{5}He and ^{5}Li above 16 MeV excitation. For both forces the three sd-shell single-particle energies were varied to obtain agreement with the experimental spectrum. This fitting procedure

allowed us to determine the sd-shell single-particle energies and to predict the spins and parities of two other T = ½ levels at 22 and 25 MeV. The Kurath force predicts the correct sequence of levels but an inadequate amount of splitting between levels. The Tabakin potential gives larger splittings between levels. The wave functions obtained for the two cases are discussed from the point of view of the "S-forbiddenness" selection rule observed in the two-nucleon pick-up reactions on ^{7}Li. (auth)

38091 NUCLEON CORRELATION EFFECT ON THE QUADRUPOLE TRANSITION IN $^{4}_{\Lambda}$He. Lodhi, M. A. K. (Texas Tech. Univ., Lubbock). Phys. Rev., C; 1: 1732-5(May 1970).

The shell-model calculations were performed for the E2 decay rate of $^{4}_{\Lambda}$He*. It is shown that the inclusion of nucleon–nucleon correlation in the usual independent-particle shell-model (IPSM) charge-density distribution of the core nucleus ^{5}He provides an adequate description and leads to an identification of $^{4}_{\Lambda}$He* as an isomeric state. It also provides a method of studying the effect of core polarization. The treatment of the core nucleus can be applied with confidence to other nuclear systems. It would be particularly useful for those nuclei which cannot be well described by simple IPSM wave functions, e.g., ^{6}Li. (auth)

38092 HIGH-ENERGY OPTICAL POTENTIAL AND NUCLEAR CORRELATIONS. Kujawski, E. (Massachusetts Inst. of Tech., Cambridge. Univ. of Maryland, College Park). Phys. Rev., C; 1: 1651-67(May 1970).

The high-energy elastic scattering of nucleons by nuclei is studied using the optical-potential operator provided by Watson's multiple-scattering theory. The main motivation is to investigate the possibility of detecting two-body correlations in terms of an optical potential. An expression is obtained for the second-order potential in coordinate space which explicitly exhibits its nonlocality in terms of the two-body correlations arising from the Pauli principle and the repulsive core of the nucleon–nucleon interaction. A self-consistent analysis of the elastic scattering of 1-GeV protons on ^{4}He is performed using a reasonable nucleon–nucleon scattering amplitude, the one-body density obtained from elastic electron scattering, and a parametrization for the two-body density consistent with the one-body density and dependent upon a parameter identifiable as a correlation length. It is also attempted to discriminate among several sets of nucleon–nucleon phase shifts at 630 MeV. The scattering of 1-GeV protons by ^{12}C and ^{16}O is studied in order to investigate the relative importance of Pauli and short-range correlations. The work is critically compared with that of several others. (auth)

38093 GAMMA RAY–NEUTRON BRANCHING RATIO IN THE TRITON–DEUTERON REACTION. Kosiara, A.; Willard, H. B. (Case Western Reserve Univ., Cleveland). Phys. Lett.; 32B: 99-100(8 Jun 1970).

The cross section for the ^{3}H(^{2}H,γ)^{5}He process has been measured. At E_d = 1025 keV, 90° (lab) its value is 0.44 ± 0.12 μb/sr and the γ ray–neutron branching ratio is 2.3×10^{-5}. (auth)

Nuclear Properties and Reactions, 6 ≤ A ≤ 19

Refer also to abstracts 38056, 38076, 38083, 38084, 38092, 38175, 38303, 38306, 38313, and 38351.

38094 (ANU-P-486) THE 1.67-MeV LEVEL IN ^{9}Be. Tucker, S. N.; Treacy, P. B.; Komarov, V. V. (Australian National Univ., Canberra. Research School of Physical Sciences). [1970]. 7p. Dep. CFSTI (U. S. Sales Only).

A study was made of the 1.67-MeV level in ^{9}Be using 6.0-MeV protons to populate it via the ^{9}Be(p,p')^{9}Be* reaction. The spectrum of protons inelastically scattered at a 90° laboratory angle was fitted with a line shape based on R-matrix theory. The position of the line-shape peak above the ^{9}Be + n threshold is (25^{+1}_{-3}) keV; this figure and deduced level parameters are in disagreement with recent results from a similar fit to the ^{9}Be(γ, n)^{8}Be reaction. (auth) (Australia)

38095 (ANU-P-489) A STUDY OF THE REACTION ^{11}B(^{3}He,γ_0)^{14}N IN THE ENERGY RANGE FROM $E_{^3He}$ = 0.9 TO 2.6 MeV. Black, J. L.; Caelli, W. J.; Davidson, W. F.; Watson, R. B. (Australian National Univ., Canberra. Research School of Physical Sciences). [1970]. 18p. Dep. CFSTI (U.S. Sales Only).

Excitation functions for the reaction ^{11}B(^{3}He,γ_0)^{14}N were measured at 0 and 90° in 25-kev steps for helium-3 energies between 0.9 and 2.6 MeV. The γ-ray detector used was a 23.8 × 25.4 cm NaI(Tl) crystal. When the yield from the reaction is divided by the barrier penetration factor a broad resonance is seen at both angles, which peaks at a helium-3 energy of 1.4 MeV, corresponding to an excitation energy in ^{14}N of 21.8 MeV. The (^{3}He,γ) excitation functions are compared with other reaction channels leading to the same excitation region in ^{14}N. Angular distributions were measured at six helium-3 energies and were found to be approximately isotropic. Possible spin assignments are discussed. (Australia)

38096 (ANU-P-491) A 6^{+} LEVEL IN ^{16}O. Ophel, T. R.; Cloud, S. D.; Martin, Ph.; Morris, J. M. (Australian National Univ., Canberra. Research School of Physical Sciences). [1970]. 5p. Dep. CFSTI (U. S. Sales Only).

Studies of the ^{12}C(α,α) and ^{12}C(α,α') reactions provided evidence for a 6^{+} level in ^{16}O at an excitation energy of 14.79 MeV. (auth) (Australia)

38097 (CEA-CONF-1499) MECHANISMS OF THE NUCLEAR REACTIONS ^{9}Be(p,p)^{9}Be AND ^{9}Be(p,α_0)^{6}Li AT LOW ENERGIES. Bontemps, A.; Longequeue, N., Ligeon, E.; Cavaignac, J. F. (Comissariat à l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires. Grenoble Univ. (France). Institut des Sciences Nucleaires). [1970]. 5p. (In French). (CONF-700313-1). Dep. CFSTI (U. S. Sales Only).

From Symposium on the Mechanisms of Nuclear Reactions, Grenoble, France.

In order to unify the different results relating to the exited levels of ^{10}B, the reactions ^{9}Be(p,p)^{9}Be and ^{9}Be(p,α_0)^{6}Li were studied in the energy range 0.8 to 1.5 MeV. (France)

38098 (LYCEN-7009) (α,2α) REACTION ON ^{6}Li, ^{7}Li, ^{9}Be, ^{12}C AND ^{16}O AT 55 MeV. Pizzi, J. R.; Gaillard, M.; Gaillard, P.; Guichard, A.; Gusakow, M.; Ruhla, C. (Lyon Univ. (France). Institut de Physique Nucleaire). 26 Feb 1970. 4p. (In French). Dep. CFSTI (U.S. Sales Only).

The (α,2α) reaction was studied on ^{6}Li, ^{7}Li, ^{9}Be, ^{12}C, and ^{16}O nuclei at 55 MeV, assuming a quasi-elastic scattering mechanism. The experimental results were studied in the framework of the plane-wave impulse approximation. The angular distributions obtained are given. (auth) (France)

38099 (LYCEN-7021) ASYMMETRIES PRODUCED BY 28-MeV VECTOR-POLARIZED DEUTERONS IN ELASTIC SCATTERINGS ON ^{12}C, ^{28}Si, ^{40}Ca. Burq, J. P.; Hadinger, G.; Kouloumdjian, J.; Meyer, J. (Lyon Univ. (France). Institut de Physique Nucleaire). 31 Mar 1970. 21p. (In French). Dep. CFSTI (U. S. Sales Only).

The asymmetries that appear in the elastic scattering of vector polarized deuterons were measured. The deuterons were produced in a source adapted to the 28-MeV synchrocyclotron of the Nuclear Institute of Lyon. The interpretation made in the framework of the optical model gives very satisfying results for the experimental asymmetries. (France)

38100 (LYCEN-7031) A THEORETICAL ANALYSIS OF (α,2α) REACTIONS USING TRIANGULAR GRAPHS. Mithra, B.; Laverriere, R. (Lyon Univ. (France). Institut de Physique Nucleaire). May 1970. 17p. Dep. CFSTI (U. S. Sales Only).

This study concerns (α,2α) reactions in the scheme of the dispersion theory. Triangular graphs taking into account a final-state interaction are considered. Numerical calculations are made for 56-MeV incident energy with ^{6}Li, ^{9}Be, ^{12}C, and ^{16}O as targets in a coplanar and symmetrical geometry. A good agreement is obtained, especially for carbon and oxygen. (auth) (France)

38101 (ORNL-TM-2998) REPORT TO THE AEC NUCLEAR CROSS SECTION ADVISORY COMMITTEE. Gibbons, J. H. (Oak Ridge National Lab., Tenn.). May 1970. 24p. Dep. CFSTI.

This memo is a collection of brief reports on recent work at ORNL and on papers either published or submitted for publication during the last 6 months which are pertinent to the interests of the NCSAC. (auth)

38102 (RLO-1388-123) ELASTIC SCATTERING OF ^{16}O BY ^{16}O. Shaw, R. W. Jr.; Vandenbosch, R.; Mehta, M. K. (Washington Univ., Seattle). [1969]. 14p. Dep. CFSTI.

The excitation function at 90° c.m. was measured for ^{16}O + ^{16}O between 7.5 and 27.5 MeV c.m. The prominent gross structure observed in ^{16}O + ^{16}O is not seen, and the absolute cross section falls to much lower values at high energies. The results of the comparison of the two systems are discussed in terms of angular momentum restrictions on configurations directly coupled to the elastic channel. (auth)

38103 (RLO-1388-567) ELECTRON SCATTERING AND MUON CAPTURE BY ^{12}C AND ^{16}O IN A CONTINUUM MODEL. Friar, J. L. (Stanford Univ., Calif. Inst. of Theoretical Physics. Washington Univ., Seattle). [1968]. Contract AT(45-1)-1388. 72p. Dep. CFSTI.

The giant resonance region of ^{12}C and ^{16}O is investigated using a continuum model, which is based on configuration mixing of negative-parity particle–hole states, with the particle in the continuum. Using this model T = 1, $J^\pi = 1^-$ and 2^- electron scattering spectra are calculated as well as the 0^-, 1^-, and 2^- nuclear excitation spectra (or equivalently the neutrino spectra) in μ capture. The SU(4) relationship $M_V^2 = M_V^2 = M_A^2$ is tested and found to be satisfied in both nuclei to better than 10%. In addition, the relationship $(M_V^2) = (M_V^2)_{UD}|F_{el}(\nu_{res}^2)|^2$ is tested and found to hold to within 3%. Both of these results justify the previous work of Foldy and Walecka on calculations of total μ capture rates. The detailed behavior of the electron scattering spectra is examined as a function of momentum transfer with emphasis on the magnetic contribution to the 1^- transverse electric spectra and the giant magnetic quadrupole resonances. The momentum dependence of integrated form factors for certain regions of the excitation spectra is also investigated. (auth)

38104 CORRELATION BETWEEN NUCLEAR RADII AND BINDING ENERGIES FOR LIGHT NUCLEI. Angeli, I. (Kossuth Univ., Debrecen, Hungary); Csikai, J.; Hunyadi, I. Acta Phys. Acad. Sci. Hung.; 28: 87-90(1970).

Deviations of measured total neutron cross sections from the "black-nucleus" formula were investigated for light nuclei. Similar trends in electrical charge radii suggest that the deviations are caused by variations in the nuclear radius parameter, r_0. It was found that a definite correlation exists between r_0 and the binding energy per nucleon, ϵ, namely $r_0 \epsilon \approx 11$ MeV fm. (auth)

38105 A DOUBLE-STRIPPING STUDY OF ^{16}O STRUCTURE. Honsaker, J. L.; Hsu, T. H.; McDonald, W. J.; Neilson, G. C. (Univ. of Alberta, Edmonton). Nucl. Phys.; A144: 473-80(1970).

Angular distributions of the reaction $^{14}C(^3He,n)^{16}O$ were measured at 6 MeV for the lowest states in ^{16}O. The ground state distribution was analyzed by double-stripping DWBA and the amplitudes of sd-shell transfer determined relative to $1p^2$ transfer. The results are smaller than the values predicted by shell-model calculations. The next higher level showing a direct-reaction distribution appears to be the 1^- level at 7.12 MeV. The $6.05(0^+)$ and $6.92(2^+)$ levels do not show strong direct formation, in agreement with their supposedly predominant 4p-4h nature. Excitation functions from 3.5 to 6 MeV for these lowest levels have a resonance at 4.1 MeV as the only outstanding feature. (auth)

38106 SELF-CONSISTENT REACTION MATRIX CALCULATION OF THE PION CAPTURE RATE IN FINITE NUCLEI. Kaushal, R. S.; Waghmare, Y. R. (Indian Inst. of Tech., Kanpur, India). Nucl. Phys.; A144: 449-72(1970).

The Hartree–Fock (HF) wave functions calculated from a realistic nucleon–nucleon interaction are used to study the two-nucleon emission process following π^- capture in complex nuclei. In particular, the π^- absorption in the ^{12}C nucleus is studied. The calculated angular distributions of the absorption rate and the branching ratios are compared with available experimental and theoretical results. In some cases, the agreement of the results with experiment is found to be much better than the results obtained by various other approaches which have been used to introduce the effect of short-range correlations in the wave function of the pion-capturing pair of nucleons. Calculations are also made with harmonic oscillator wave functions. In this case the corrections to the absorption rate due to various effects are studied, in particular those arising from (i) short-range dynamical correlations, (ii) final state nucleon–nucleus scattering and (iii) final state nucleon–nucleon scattering. It is found that the pure harmonic oscillator model gives reasonably good results after including the contribution from low-lying excited states of the residual nucleus. The correction due to the first effect increases the absorption rate whereas the corrections due to the last two effects suppress the absorption for back-to-back emission of the nucleon pair. Further, it is noticed that the second correction is more important than the third one. The effect of these corrections on the branching ratio $R = W(pn \to nn)/W(pp \to pn)$ is studied in detail. Finally, it is pointed out that the Jastrow method of introducing short-range correlations is inadequate in explaining the angular distributions and branching ratio data simultaneously. (auth)

38107 DWBA CALCULATIONS OF THE REACTION $^{10}B(d,p,\gamma)^{11}B$ AT LOW DEUTERON ENERGIES. Der, R. (Karl Marx-Univ., Leipzig); Otto, G.; Schmidt, K.-D.; Hehl, K. Acta Phys. Acad. Sci. Hung.; 28: 17-29(1970).

The mechanism of the reaction $^{10}B(d,p,\gamma)^{11}B$ at $1.5 \lesssim E_d \lesssim 3$ MeV and optical-model parametrization are investigated. A set of parameters is reported that describes many transitions with $Q \lesssim 2.47$ MeV in the energy region considered. It also describes the Q = 4.77 MeV transition, if an additional Hauser–Feshbach contribution is assumed. The p-γ-angular correlation functions are calculated as a further test of the DWBA. The spin-orbit coupling is found to give, in general, an improved fit to the experimental differential cross-sections, and a very strong dependence of the angular correlation and polarization on the spin-orbit parameter is observed. (auth)

38108 $^{19}F(d,p)^{20}F$ REACTION AT E_d = 600 keV. Schlenk, B.; Zimanyi, J. (Inst. of Nuclear Research, Debrecen, Hungary). Acta Phys. Acad. Sci. Hung.; 28: 5-11(1970).

The angular distributions of ten proton groups from the $^{19}F(d,p)$ ^{20}F nuclear reaction were measured at E_d = 600 keV. DWBA calculations reproduce the angular distributions of five proton groups, and lead to acceptable spectroscopic factors. At very low deuteron bombarding energies, the DWBA analysis is largely independent of uncertainties in deuteron optical potentials. (auth)

38109 ELECTRODISINTEGRATION OF ^{12}C NUCLEI BY HIGH-ENERGY ELECTRONS. Vysotskaya, A. V.; Afanas'ev, N. G. Yadern. Fiz.; 11: 942-5(May 1970). (In Russian).

Spectra of protons emitted from the ^{12}O nuclei are measured in the energy interval from 15 to 60 MeV at various angles from 20 to 150° and at the incident electron energies of 100, 150, and 200 MeV. Angular distributions of the protons with fixed energies are obtained. Investigation of the yield dependence on the target thickness shows that the contribution from photoprocesses is small at the thickness used. (auth)

38110 ANGULAR DISTRIBUTIONS OF PROTONS IN THE (γ,p) REACTION ON ^7Li AT PHOTON ENERGIES 620 AND 1115 MeV. Antuf'ev, Yu. P.; Agranovich, V. L.; Ganenko, V. B.; Kuz'menko, V. S.; Miroshnichenko, I. I.; Sanin, V. M.; Sorokin, P. V. (Physical-Technical Inst., Kharkov). Yadern. Fiz.; 11: 948-52(May 1970). (In Russian).

Angular distributions of photoprotons were investigated in the $\gamma + {}^7Li \to p + X$ reaction at maximum photon energies 620 and 1115 MeV for proton energies 80, 160, and 285 MeV and angles from 25° to 140° in the lab. system. Experimental results are in reasonable agreement with a simple calculation based on the model of the single pion photoproduction and disintegration of quasideuterons in the region where the contribution from double photoproduction is small. (auth)

38111 CHARGE EXCHANGE PART OF THE EFFECTIVE TWO-BODY INTERACTION. Anderson, J. D. (Univ. of California, Livermore); Wong, C.; Madsen, V. A. Phys. Rev. Lett.; 24: 1074-8(11 May 1970).

From an essentially model-independent analysis of the ratio of cross sections for the reactions $^7Li(p,n_0)^7Be_{g.s.}$, $^7Li(p,n_1)^7Be(0.43$ MeV), and $^6Li(p,n_0)^6Be_{g.s.}$, it is concluded that $V_{\sigma\tau}/V_\tau = 0.66 \pm 0.08$ and is independent of bombarding energy from 10 to 20 MeV. (auth)

38112 NEUTRON TOTAL ELASTIC SCATTERING CROSS SECTION MEASUREMENT ON ^{16}O. Borelli, F. (Boris Kidric Inst., Belgrade). Fizika (Zagreb); 2: 97-102(1970).

Total cross section measurements of elastically scattered neutrons on ^{16}O were done in the neutron energy range between 14 and 19 MeV. A liquid oxygen target in an annular-sphere geometry was used. A resonance structure at 17.3-MeV incident neutron energy was found, corresponding to the resonance of the same height and width as in total neutron cross section. A resonant amplitude of the single particle type superimposed on the optical potential scattering amplitude was assumed and the analysis gave an assignment of $s_{\frac{1}{2}}$ for the state at 20.4 MeV excitation energy in ^{17}O. (auth)

38113 INVESTIGATIONS ON ^{10}B LEVELS USING $^9Be(d,n)^{10}B$ REACTION. Pose, H.; Truetzschler, K.; Wiesner, K. (Technische Univ., Dresden). Kernenergie; 13: 85-7(Mar 1970). (In German).

With a time-of-flight system at a pulsed 500-kV cascade generator the neutron groups from the $^9Be(d,n)^{10}B$ reaction were analyzed. In spite of good resolution and low background the study provided no evidence for the existence of an excited state in ^{10}Be near 2.86 MeV. This result is in agreement with the theoretical conclusions derived from the individual-particle model. (auth)

38114 SUBSTATE POPULATIONS AND NUCLEAR POLARIZATION PRODUCED BY INELASTIC ALPHA-PARTICLE SCATTERING ON ^{12}C. Hayward, T. D.; Schmidt, F. H. (Univ. of Washington, Seattle). Phys. Rev., C; 1: 923-35(Mar 1970).

The normalized α-γ angular correlation is measured in the reaction plane for excitation of the 4.44-MeV, 2^+ state of ^{12}C at 22.750 MeV. These data yield the relative populations $(a_m)^2$ of the three magnetic substates referred to the normal to the reaction plane. The ambiguity between $(a_{+2})^2$ and $(a_{-2})^2$ is resolved by coincidence measurements of the circular polarization of de-excitation γ rays emitted near the normal to the reaction plane.

The inelastic scattering process can then be dissected into partial differential cross sections σ_m to the substates. The results show that each σ_m has a different angular dependence. σ_0 has the most regular and pronounced diffractionlike structure, σ_{-2} dominates out to 75°, and σ_{+2} dominates thereafter. Thus, the excited nuclei spin in the sense of classical hard-sphere scattering with friction out to ≈75°, and in the reverse sense from ≈75° to ≈170°. The nuclear polarization exhibits an oscillatory character as a function of angle. Comparison of the results with diffraction-model calculations, and with distorted-wave Born-approximation calculations, is poor. In principle, the experimental method, though difficult, could be applied to nuclei which are more accurately described by nuclear models than is ^{12}C. (auth)

38115 $^{18}O(t,p_1\gamma)^{20}O$ ANGULAR CORRELATION. Nightingale, R. W.; Becker, J. A.; McDonald, R. E.; Kohler, D. (Lockheed Palo Alto Research Lab., Palo Alto, Calif.). Phys. Rev., C; 1: 893-5(Mar 1970).

A J = 2 assignment for the ^{20}O 1.67-MeV level is deduced from a measurement of the angular correlation of 1.67-MeV γ radiation. The level is populated via the $^{18}O(t,p)^{20}O$ reaction using 2.0-MeV tritons incident on an ^{18}O gas target. Alignment of nuclear recoils is maintained in this environment. (auth)

38116 RECOIL ANGULAR DISTRIBUTIONS OF THE $^{6}Li(d,n)^{7}Be$ AND $^{12}C(d,n)^{13}N$ REACTIONS. Gangadharan, S.; Wolke, R. L. (Univ. of Pittsburgh). Phys. Rev., C; 1: 1333-41 (Apr 1970).

The reactions $^{6}Li(d,n)^{7}Be$ (gs + 0.431 MeV) and $^{12}C(d,n)^{13}N$ (gs) are studied by recoil spectrometry at bombarding energies of 12, 15, and 17 MeV. The recoils are detected by a solid-state detector in coincidence with the neutrons detected by a plastic scintillator. Experimental absolute differential cross sections at the three bombarding energies are given for both reactions. Also given are the excitation functions over the energy region 12 to 17 MeV at about 60° recoil cm angle for both reactions, and for the reaction $^{19}F(d,n)^{20}Ne$ (gs). The ^{6}Li and ^{12}C reactions are analyzed in the distorted-wave Born approximation (DWBA), taking into account the effects of spin-orbit force, finite range, and nonlocality corrections. The agreement between the experimental and theoretical angular distributions is good for the ^{6}Li reaction, and the agreement for the ^{12}C reaction is fair at 17 MeV. The excitation functions for the two reactions are relatively smooth. The experimental absolute differential cross sections for the ^{6}Li reaction agree fairly well with the theoretical cross sections obtained by incorporating the spectroscopic factors from recent shell-model calculations. For the ^{12}C reaction, the spectroscopic factor extracted from the experimental cross section agrees well with the theoretical value at 17 MeV. The experimental cross sections at 12 and 15 MeV are higher than the theoretical estimates; some possible explanations are discussed. The ratios of the experimental to the theoretical cross sections as a function of bombarding energy follow the same trend as for the reaction $^{12}C(d,p)^{13}C$ (gs). An evaluation of the technique of recoil spectrometry for studying (d,n) and other nuclear reactions is given. (auth)

38117 EXCITED NUCLEAR STATES DURING CAPTURE OF NEGATIVE MUONS BY CARBON AND OXYGEN. Budyashov, Yu. G.; Zinov, V. G.; Konin, A. D.; Medved, S. V.; Mukhin, A. I.; Ozerov, E. B.; Chatrchyan, A. M.; Eramzhyan, R. A. (Joint Inst. for Nuclear Research, Dubna, USSR). Zh. Eksp. Theor. Fiz.; 58: 1211-18(Apr 1970). (In Russian).

The probabilities for formation of excited levels of the daughter nuclei produced by capture of negative muons by carbon or oxygen nuclei are studied. The total transition rate to all excited bound states of the $^{12}B^*$ nucleus is determined for the $^{12}C + \mu^- \rightarrow {}^{12}B^* + \nu$ reaction; it is equal to $(0.76 \pm 0.14)\cdot10^3$ sec^{-1}. For the $^{16}O + \mu^- \rightarrow {}^{15}N^* + n + \nu$ reaction the total transition rate $^{15}N^*$ excited bound states with positive parity is found to be $(14 \pm 5)\cdot10^3$ sec^{-1} and the transition rate to the $^{15}N^*$ spin $\frac{3}{2}$ level is $(20 \pm 5)\cdot10^3$ sec^{-1}. Part of the results strongly differ from the theoretical predictions. (auth)

38118 IMPORTANCE OF HIGHER ORDER CORRECTIONS TO THE EFFECTIVE CHARGE. Siegel, Stan; Zamick, Larry (Rutgers-The State Univ., New Brunswick, N. J.). Nucl. Phys.; A145: 89-128(1970).

Rayleigh-Schroedinger perturbation theory through second order is applied to the problem of electromagnetic transitions in closed-shell-plus-one-nucleon nuclei. The concept of effective charge is introduced and its usefulness as a physical parameter is discussed. Effective charges relevant to quadrupole moments and E2 transitions in ^{17}O and ^{17}F are calculated in first and second order. The semi-realistic Kallio-Kolltveit interaction is used to evaluate two-body matrix elements. The Tamm-Dancoff and random phase approximations are also discussed, and results of effective charge calculations made in these approximations are presented. In a set of appendices, explicit formulas for the second-order corrections to the reduced matrix element which describes electromagnetic transitions between single-particle states are given (appendices 1 and 2). Also included in these appendices is a discussion of state dependent separation distances in the Kallio-Kolltveit interaction (appendix 3). In appendix 4, results of effective charge calculations carried out with Kuo-Brown two-body matrix elements are presented. Finally, in appendix 5, E2 effective charges relevant to the closed-shell-minus-one-nucleon nuclei ^{15}O, ^{15}N, ^{39}Ca and ^{39}K are given. (auth)

38119 ENERGY LEVELS OF ^{16}N FROM THE REACTION $^{18}O(d,\alpha)^{16}N$. Bonner, T. I. (Univ. of Wisconsin, Madison). Phys. Rev., C; 1: 1699-1709(May 1970).

Energy levels of ^{16}N were studied with the $^{18}O(d,\alpha)^{16}N$ reaction at deuteron energies of 4.75 to 11.5 MeV. No evidence was found for levels between 0.4- and 3.3-MeV excitation energy. Eleven levels were identified or tentatively identified between excitation energies of 8.4 and 10.3 MeV in addition to 32 previously observed levels below an excitation energy of 8.4 MeV. The fourth, sixth, and seventh excited states at 3.36, 3.96, and 4.32 MeV appear to be populated partially via a two-nucleon pickup reaction at E_d = 10.0, 10.6, and 11.2 MeV; and tentative L values are obtained. (auth)

38120 PION ELASTIC SCATTERING FROM CARBON AND OXYGEN AT 30 MeV. Marshall, J. F. (Univ. of Rochester, N. Y.); Nordberg, M. E. Jr.; Burman, R. L. Phys. Rev., C; 1: 1685-92(May 1970).

Measurements of elastic scattering were made for π^+ and π^- beams at 30 MeV on a carbon target and π^+ on oxygen at 30 MeV. A magnetic spectrometer utilizing wire spark chambers was used to measure the momenta of the scattered pions over the angular range 40−120 deg. The energy resolution was about 4 MeV full width at half maximum at 30 MeV, which is sufficient to resolve the first excited states of carbon and oxygen. Inelastic scattering from the lower excited states was estimated. Fits of the Kisslinger optical model to the data were made. (auth)

38121 EFFECTS OF GROUND-STATE CORRELATIONS ON THE ODD-PARITY STATES OF ^{16}O. Dang, G. Do (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France); Goulard, B.; Laverne, A. Phys. Rev., C; 1: 1745-51 (May 1970).

Taking into account the mixing of 2p-2h components in the ground state, a method is developed to define the odd-parity excited states of ^{16}O. Using the effective potential given by Gillet, the excitation energies are given, and the components of the wave functions are put in a form which can be readily used for the computation of electromagnetic transition probabilities. The 3p-3h components in these wave functions are found to be important. (auth)

38122 LIFETIME MEASUREMENTS FROM THE ANALYSIS OF DOPPLER-BROADENED SHAPES. Cockburn, P. M.; Stark, W. J.; Krone, R. W. (Univ. of Kansas, Lawrence). Contract AT(11-1)-1120. Phys. Rev., C; 1: 1757-60(May 1970).

A formalism for the analysis of Doppler-broadened γ-ray line shapes observed in (a,bγ) reactions was developed in order to measure nuclear lifetimes. The technique, which is generally applicable to lifetime determinations in the range 5×10^{-15} to 10^{-12} sec, was employed to measure the lifetimes of the levels at 4.43 MeV in ^{12}C and 6.92 MeV in ^{16}O. Results of 65 ± 9 and 6.4 fsec, respectively, were obtained. (auth)

38123 ANGULAR DISTRIBUTIONS OF THE REACTION $^{6}Li(d,\alpha)^{4}He$ IN THE RANGE 600 TO 1200 keV. Huez, M.; Dumont, P. D.; Robaye, G.; Delbrouck, J. M. (Univ., Liege). Bull. Soc. Roy. Sci. Liege; 38: 681-6(1969). (In French).

For an energy range from 600 to 1200 keV, the angular distributions of α particles from the $^{6}Li(d,\alpha)^{4}He$ reaction are established. All cross sections are obtained in mb/sr. The $A_2(E)$ coefficient of the angular distribution $(d\sigma/d\Omega)^* = (d\sigma/d\Omega)^*_{90°}\,(1 + A_2(E)\cos^2\theta^*)$ is deduced. (auth)

38124 REACTIONS IN THE EVEN PARITY STATES OF ^{6}Li. Hackenbroich, H. H.; Heiss, P. (Univ., Cologne). Phys. Lett.; 32B: 78-80(8 Jun 1970).

Reactions in the even-parity T = 0 states of ^{6}Li were calculated starting from a realistic 6-nucleon Hamiltonian. Low-energy results agree well with experiments. Large $\alpha + d \rightleftharpoons {}^{3}H + {}^{3}He$ transitions in the 1^+ state due to compound state coupling were found at higher energies. (auth)

38125 A 6^+ LEVEL IN ^{16}O. Ophel, T. R.; Cloud, S. D.; Martin, Ph.; Morris, J. M. (Australian National Univ., Canberra). Phys. Lett.; 32B: 101-2(8 Jun 1970).

Studies of the $^{12}C(\alpha,\alpha_0)$ and $^{12}C(\alpha,\alpha')$ reactions have provided evidence for a 6^+ level in ^{16}O at an excitation energy of 14.79 MeV. (auth)

38126 THEORY OF $(\pi^+,2p)$ REACTIONS ON LIGHT NUCLEI. Kolybasov, V. M.; Lomonosova, T. A. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz.; 11: 578-88(Mar 1970). (In Russian).

The problem of the mechanism of $(\pi^+,2p)$ reactions on light nuclei is treated. Two of the simplest mechanisms, the deuteron and the α-particle ones, are compared. The following quantities are obtained: energy dependence of cross section, momentum and energy distribution of recoil nuclei, angular correlation of two fast protons, energy distribution of the relative motion of two protons. The question of which of the parameters is most sensible to the mechanism of the process is studied. (auth)

38127 PARTIAL TRANSITIONS AT THE CAPTURE OF μ^- MESONS BY ^{11}B AND ^{14}N NUCLEI. Vartanyan, V. A.; Dmitrieva, T. A.; Eger, G.-U.; Kissener, G. R.; Eramzhyan, R. A. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 11: 528-32(Mar 1970). (In Russian).

Probabilities of the partial transitions $\mu^- + {}^{11}B \rightarrow \nu + {}^{11}Be$ ($1/2^-$, $3/2^-$; E = 320 keV) and $\mu^- + {}^{14}N \rightarrow \nu + {}^{14}C$ (2^+, 1; E = 7.01 MeV) are calculated in the framework of the shell model with intermediate coupling. At $g_P/g_A = 7$ the probabilities of transitions turned out to be 1105 and $11 \cdot 10^3$ sec^{-1}, respectively, which are in good agreement with the experimental data. (auth)

38128 ELASTIC AND INELASTIC SCATTERING OF 14.1 MeV NEUTRONS FROM FLUORINE. Clarke, R. L.; Perrin, P. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Nucl. Phys.; A147: 174-82(1970).

The angular distributions and cross sections for elastic and inelastic scattering of 14-MeV neutrons from fluorine were measured. The observed inelastic group was assigned mainly to the state at 1.56 MeV. The angular distributions generally agree with the predictions of the optical model and the DWBA. The observed cross section for the inelastic group corresponds to a value of $|M|^2 = 7$ in Weisskopf units. (auth)

38129 NEUTRON ENERGY SPECTRA FOLLOWING RADIATIVE PION ABSORPTION ON ^{16}O AND ^{28}Si NUCLEI. Holland, M. M.; Minehart, R. C.; Sobottka, S. E. (Univ. of Virginia, Charlottesville). Nucl. Phys.; A147: 249-57(1970).

The energy spectra of neutrons emitted following radiative capture on ^{16}O and ^{28}Si nuclei of negative pions at rest have been measured. There is some evidence in the ^{16}O spectrum for a group of neutrons between 4 and 5 MeV which may correspond to decay of a giant resonance state, while both the ^{16}O and ^{28}Si data have an excess of neutrons at the higher energies which may be due to direct emission of neutrons. (auth)

38130 A SURVEY OF NEW RESONANCES IN THE $_{15}$N(alpha, gamma)$_{19}$F REACTION. Aitken, J. H.; Azuma, R. E.; Litherland, A. E.; Charlesworth, A. M.; Rogers, D. W. O.; Simpson, J. J. (Univ. of Toronto). Can. J. Phys.; 48: 1617-21(1 Jul 1970).

Thirteen new resonances in the $^{15}N(\alpha,\gamma)^{19}F$ reaction have been discovered in the region E_α = 600 to 3150 keV. γ-Decay schemes and radiative yields are reported for several of them. Spins and parities for 10 levels in ^{19}F are also reported. (auth) (Canada)

38131 DECAY MODES OF ^{9}Li AND STATES OF ^{9}Be. Chen, Y. S.; Tombrello, T. A.; Kavanagh, R. W. (California Inst. of Tech., Pasadena). Nucl. Phys.; A146: 136-48(1970).

The β-decay of the ^{9}Li nucleus and the subsequent particle decays of the unbound states of the ^{9}Be nucleus have been investigated with two complementary techniques, a recoil-particle method and a beta-neutron coincidence method. ^{9}Li nuclei were produced by the $^{16}O(^7Li, {}^9Li)^{14}O$ reaction at a bombarding energy of 20 MeV and by the $^3H(^7Li, {}^9Li)p$ reaction with a 14 MeV bombarding energy. The energy spectrum of the delayed alphas and the time-of-flight spectrum of the delayed neutrons were obtained. The half-life was measured to be 177 ± 3 ms. Besides the known decay branches to the ground state and to the 2.43 MeV state in ^{9}Be, a new decay branch to an unbound state in ^{9}Be at an excitation energy of 2.78 ± 0.12 MeV was observed. The branching ratios and the log ft values were found to be $(65.0^{\pm}{}^{?}_{?})\%$, $(32.0^{\pm}{}^{?}_{?})\%$, $(3.0^{\pm}{}^{?}_{?})\%$ and $5.12^{\pm}{}^{?}_{?}$, $5.00^{\pm}{}^{?}_{?}$, $5.97^{\pm}{}^{?}_{?}$ to the ground state, the 2.43 MeV state and the 2.78 MeV state, respectively. The observed properties of the 2.78 MeV state favor an assignment of $1/2^-$. This state decays mainly by neutron emission to the ground state of ^{8}Be and has a c.m. width of 1.10 ± 0.12 MeV. The fraction of the decays of the 2.43 MeV state in ^{9}Be involving emission of a neutron to the ground state of ^{8}Be was found to be (6.4 ± 1.2)%. (auth)

38132 FINAL-STATE-INTERACTION EFFECTS IN NEUTRON PAIR EMISSION FROM PION CAPTURE ON ^{12}C. Cheshire, D. L.; Sobottka, S. E. (Univ. of Virginia, Charlottesville). Nucl. Phys.; A146: 129-35(1970).

Energy spectra of neutron pairs from the $^{12}C(\pi^-, 2n)^{10}B$ reaction have been measured. The results disagree with calculations which include the neutron–neutron final state interaction, and are in better agreement with calculations which include no final-state interactions at all. (auth)

38133 ENERGY SEPARATION OF THE DOUBLET AT 9.15 MeV IN ^{15}N. Reisman, F. D.; Young, F. C. (Univ. of Maryland, College Park). Nucl. Phys.; A146: 177-81(1970).

The energy level separation of the doublet at 9.15 MeV in ^{15}N has been measured using the $^{14}N(d,p\gamma)^{15}N$ reaction. Gamma rays were measured in coincidence with protons which were detected with a position-sensitive detector located at the exit of a magnetic spectrometer. Branching ratios for different γ-decays were observed to vary across the proton group in a manner consistent with the known modes of decay of each member of the doublet. This variation was used to obtain a value of 2.8 ± 0.5 keV for the energy level separation. (auth)

38134 PROTON–GAMMA ANGULAR CORRELATIONS ON ^{11}B AND ^{31}P. Hulubei, H.; Berinde, A.; Martalogu, N.; Neamu, I.; Scintei, N.; Teodorescu, C. M.; Zoran, V. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys.; 15: 3-9(1970).

The angular correlations of $^{11}B(p,p_1\gamma)$ (Q = −2.13 MeV) at an incident proton energy of E_p = 5.9 MeV and of $^{31}P(p,p_1\gamma)$ (Q = −1.27 MeV) and $^{31}P(p,p_2\gamma)$ (Q = −2.23 MeV) at energies of E_p = 5.8 MeV and 6.6 MeV were measured. The $^{11}B(p,p'\gamma)$ reaction may be explained by the single resonance compound nucleus theory, whereas the $^{31}P(p,p'\gamma)$ experimental results are consistent with the statistical theory of the compound nucleus. (auth)

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Refer also to abstracts 36564, 36639, 37549, 38099, 38101, 38104, 38118, 38129, 38134, 38245, 38263, 38300, 38310, and 38373.

38135 (COO–1746–42) ENERGY DEPENDENT BETA–GAMMA CIRCULAR POLARIZATION AND NUCLEAR MATRIX ELEMENTS OF ^{86}Rb. Bosken, J. J.; Ohlms, D. E.; Simms, P. C. (Purdue Univ., Lafayette, Ind. Dept. of Physics). [1970]. 16p. Dep. CFSTI.

The energy dependent beta-gamma circular polarization was measured in order to set better limits on the matrix element ratio $A = \int \alpha / (\int ir/\rho)$ for the 696-keV first forbidden beta transition of ^{86}Rb. The results show that A is consistent with the Fujita-Eichler relation, so the contributions of the off-diagonal matrix elements of the coulomb hamiltonian to A are small for this transition. The nuclear matrix elements are in agreement with previous results, but the limits of error were reduced. (auth)

38136 (EURFNR–776) MULTILEVEL RESONANCE ANALYSIS OF THE TOTAL NEUTRON CROSS SECTIONS OF ^{23}Na AND Ca BELOW 1 MeV. Nebe, J.; Kirouac, G. J. (Kernforschungsanlage, Karlsruhe (West Germany). Institut fuer Angewandte Kernphysik). May 1970. 19p. (KFK–1195; CN–26/13). Dep. CFSTI.

Work Performed under United States–Euratom Fast Reactor Exchange Program.

The total neutron cross sections of ^{23}Na and Ca measured with the time-of-flight facility at the Karlsruhe Isochronous Cyclotron have been analyzed below 1 MeV in order to provide neutron resonance parameters. The analysis uses the standard multilevel R-matrix formulae for a single open channel. A chi-squared fitting procedure is used for shape analysis. Resonance widths and energies have been assigned for ^{23}Na up to 900 keV. The values of l and J have been determined up to 432 keV; above this energy the assigned J values are only lower limits. In the case of Ca, the parameters of resonances between 0.5 and 1.2 MeV have been determined. In many cases new differential data for Ca were used to verify the l value obtained by fitting the resonance. The channel radius and s- and p-wave strength functions of this nucleus are also discussed. (auth)

38137 (IFA–M–44) PHOTONEUTRON CROSS SECTION FOR ^{75}As AND ITS FINE STRUCTURE. Baciu, G.; Catana, D.; Deberth, C.; Iliescu, C.; Cirstoiu, B. (Academia R. S. R., Bucharest. In-

stitutul de Fizica Atomica). [1970]. 9p. Dep. CFSTI (U. S. Sales Only).

The cross section for the ^{75}As (γ, Σn) reaction was measured from threshold to 25 MeV with a small energy bin (~100 keV). Marked structure was observed in the total photoneutron cross section at several energies below and in the giant resonance. This structure of the cross section is ascribed to the dipole-quadrupole coupling influence. (auth)

38138 (IS-T-351) INVESTIGATION OF ISOBARIC SPIN SPLITTING IN THE GIANT RESONANCE OF ^{64}Zn. Schamber, Frederick Herold (Ames Lab., Iowa). Feb 1970. Contract W-7405-eng-82. 188p. Dep. CFSTI.

Thesis.

Relative cross sections for the reactions $^{64}Zn(\gamma,n)^{63}Zn$, $^{64}Zn(\gamma,np)^{62}Cu$, and $^{64}Zn(\gamma,2n)^{62}Zn$ were simultaneously measured using 10 to 40-MeV bremsstrahlung. The positron activities were detected by coincident gamma rays, and the three activities were separated by half-life. The (γ,np) cross section is seen to be split into a strong and distinct resonance at 25 MeV and a broad component which rises on the trailing edge of the dominant resonance. The 25-MeV (γ,np) peak is very similar in shape to the (γ,n) resonance centered at 17.5 MeV and is about 20% of the (γ,n) amplitude. The (γ,2n) cross section is also at maximum near 25 MeV but is less than $1/3$ of the (γ,np) amplitude; thus, the large (γ,np) strength is apparently not statistical in origin. The (γ,np) resonance is identified with the $T_>$ isospin component of the giant resonance. This identification is consistent with estimates of the relative T component strengths and energy splitting obtained with recently published isospin sum rules, and the enhancement of the (γ,np) reaction channel can be understood from the proton instability of known $T = 5/2$ analog levels in the neutron-residual ^{63}Zn nucleus. (auth)

38139 (KFK-1160) SEARCH FOR PARITY VIOLATION IN THE 2,010-MeV TRANSITION IN ^{41}Ca AFTER POLARIZED NEUTRON CAPTURE. Eichler, J. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Experimentelle Kernphysik). Mar 1970. 9p. Dep. CFSTI (U. S. Sales Only).

Polarized states were produced in ^{41}Ca by capture of polarized thermal neutrons. The asymmetry coefficient A in the angular distribution of the 2.010 MeV ($3/2^+ - 1/2^-$) γ-ray was $A = (1.1 \pm 3.2) \times 10^{-4}$. (auth)

38140 (N-70-19440) ANGULAR CORRELATIONS IN THE REACTION $^{58}Ni(\alpha,\alpha'\gamma)$ AT 1.45-MeV EXCITED STATE. Baron, Norton; Leonard, Regis; Stewart, William M. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Feb 1970. 34p. (NASA-TN-D-5585; E-5124). CFSTI.

Differential cross sections for elastic scattering and excitation of the 1.452-MeV 2(+) state of nickel-58 were measured for 41-MeV incident alpha particles. The angular correlation between the inelastically scattered alpha particles and the gamma rays emitted in the plane of original scattering in the subsequent nuclear decay was measured also for the excitation of the 1.452-MeV state. The data are compared with optical model calculations of the elastic cross sections and distorted waves Born approximation calculations of the 2(+) cross sections and correlation symmetry angles. (auth) (STAR)

38141 (ORNL-4517) NEUTRON ELASTIC- AND INELASTIC-SCATTERING CROSS SECTIONS FOR Si IN THE ENERGY RANGE 4.19 TO 8.56 MeV. Kinney, W. E.; Perey, F. G. (Oak Ridge National Lab., Tenn.). Jul 1970. Contract W-7405-eng-26. 62p. Dep. CFSTI.

Numerical values are presented for neutron elastic-scattering cross sections for natural Si and cross sections per atom of natural Si for inelastic scattering to levels in ^{28}Si for incident neutron energies from 4.19 to 8.56 MeV. The data are in reasonable agreement with the results of others. The ENDF/B evaluated Si cross sections are, with few exceptions, in good agreement with experimental data. (auth)

38142 (ORNL-4539) SULFUR NEUTRON ELASTIC- AND INELASTIC-SCATTERING CROSS SECTIONS FROM 4.0 TO 8.5 MeV. Perey, F. G.; Kinney, W. E. (Oak Ridge National Lab., Tenn.). Jun 1970. Contract W-7405-eng-26. 51p. Dep. CFSTI.

Numerical values are given for neutron elastic- and inelastic-scattering cross sections from sulfur in the range 4.0 to 8.5 MeV A brief description of the experimental and data-reducing techniques is presented to assist in the evaluation of the data. The data are in general agreement with other data in this energy region. (auth)

38143 (ORNL-4549) NEUTRON ELASTIC- AND INELASTIC-SCATTERING CROSS SECTIONS FOR Co IN THE ENERGY RANGE 4.19 TO 8.56 MeV. Kinney, W. E.; Perey, F. G. (Oak Ridge National Lab., Tenn.). Jun 1970. Contract W-7405-eng-26. 105p. Dep. CFSTI.

Numerical values of neutron elastic- and inelastic-scattering cross sections for natural Co, ^{59}Co, in the incident neutron energy range from 4.19 to 8.56 MeV are presented. The results are in reasonable agreement with the results of others. Because of the high level density of Co, data at all energies of measurement are listed as angle-averaged continuum spectra which show structure previously seen in Fe and ^{60}Ni. There exists no evaluation with which to compare the data. The data partially fulfill a priority II request to NCSAG. (auth)

38144 (ORNL-4550) NEUTRON ELASTIC- AND INELASTIC-SCATTERING CROSS SECTIONS FOR Mg IN THE ENERGY RANGE 4.19 TO 8.56 MeV. Kinney, W. E.; Perey, F. G. (Oak Ridge National Lab., Tenn.). Jun 1970. Contract W-7405-eng-26. 49p. Dep. CFSTI.

Numerical values are presented for neutron elastic-scattering cross sections for natural Mg and cross sections per atom of natural Mg for inelastic scattering to levels in ^{24}Mg for incident neutron energies from 4.19 to 8.56 MeV. The data are in good agreement with the results of others. ENDF/B evaluated Mg angular distributions are in fair agreement with the data. The ENDF/B total elastic-scattering cross section agrees well with the experiment below 5 MeV, but at higher energies it is generally higher than the data, the difference being as much as 40%. The ENDF/B total inelastic-scattering cross sections are in good agreement with the experimental data. (auth)

38145 (PUC-937-378) NUCLEAR PHYSICS PROGRESS REPORT, APRIL 1969-APRIL 1970. (Princeton Univ., N. J.). Contract AT(30-1)-937. 40p. Dep. CFSTI.

Research progress from April 1969 to April 1970 is summarized. The work included development and operation of the AVF cyclotron and the associated experimental facilities, theoretical and experimental studies of nuclear reactions and nuclear structure, and studies on the use of atomic beams in nuclear physics. (J.W.R.)

38146 (RLO-1388-124) MASS DETERMINATIONS OF THE NEUTRON-DEFICIENT NUCLIDES ^{88}Zr AND ^{140}Nd BY (p,2n) THRESHOLD MEASUREMENTS. Russo, P. A.; Vandenbosch, R. (Washington Univ., Seattle). [1969]. 16p. Dep. CFSTI.

Masses of ^{140}Nd and ^{88}Zr were determined from measured thresholds of $^{141}Pr(p,2n)$ and $^{89}Y(p,2n)$ reactions. Thresholds extracted from fits of the data with the Jackson neutron evaporation model produce mass excess values of -83.57 ± 0.04 MeV for ^{88}Zr and -84.26 ± 0.06 MeV for ^{140}Nd. Measured masses are compared to existing data and to calculations based upon several semi-empirical mass formulas. (auth)

38147 (RLO-1925-40) REACTION Q VALUES FROM EPI-THRESHOLD NEUTRON SPECTRA. Kneff, D. W.; Lefevre, H. W. (Oregon Univ., Eugene); Din, G. U. (Australian National Univ., Canberra). [1970]. 11p. Dep. CFSTI.

A thick target time-of-flight technique was employed to measure neutron energies for (p,n) resonance levels near threshold in medium-weight nuclei. Combining the results with proton energy measurements of these resonances, the following ground state (p,n) Q values were deduced: ^{41}K, -1203.8 ± 0.5 keV; ^{45}Sc, $-2843.6 \pm 4.$ keV; ^{51}V, -1533.7 ± 1.5 keV; and ^{57}Fe, $-1618.2 \pm 2.$ keV. (auth)

38148 (RPI-328-173) LINEAR ACCELERATOR PROJECT. Progress Report, October 1-December 31, 1969. (Rensselaer Polytechnic Inst., Troy, N. Y.). Contract AT(30-1)-328. 24p. Dep. CFSTI.

Research progress from Oct. 1, 1969, to Dec. 31, 1969, is summarized. The research included studies on neutron cross sections and both experimental and theoretical fast reactor physics and engineering. (J.W.R.)

38149 EFFECTS OF VIBRATION-PARTICLE COUPLING ON THE PROPERTIES OF SEVERAL LIGHT ODD-MASS NUCLEI. Bailey, F. G.; Choudhury, D. C. (Polytechnic Inst. of Brooklyn). Nucl. Phys.; A144: 628-44(1970).

The effects of vibration-particle coupling on the properties of low-lying levels in several light odd-mass nuclei are investigated. It is assumed that the last odd nucleon has the $1d_{\frac{5}{2}}$ and $2s_{\frac{1}{2}}$ states available to it and is coupled to the quadrupole surface vibrations of the doubly even core of the nucleus. The Hamiltonian of the coupled system is diagonalized including all states up to three phonons. The low-lying energy spectra with their spins and parities are states up to three phonons. The low-lying energy spectra with their spins and parities are calculated and the eigenfunctions thus obtained are used to calculate the moments and electromagnetic transition rates. The reasonably good agreement

between theory and experiment in most cases indicates the importance of vibration-particle coupling in these light nuclei. (auth)

38150 A STUDY OF ^{22}Mg BY THE ^{20}Ne(^{3}He,n) REACTION. McDonald, A. B.; Adelberger, E. G. (California Inst. of Tech., Pasadena). Nucl. Phys.; A144: 593-606(1970).

The reaction ^{20}Ne(^{3}He,n)^{22}Mg was studied at incident energies between 3.4 and 9.4 MeV using a pulsed-beam neutron time-of-flight spectrometer. The ground state mass excess of ^{22}Mg was determined to be −0.391 ± 0.011 MeV. Thirteen excited states of ^{22}Mg were observed below an excitation energy of 7.3 MeV. Angular distributions were obtained at incident energies of 9.35, 8.83 and 7.83 MeV and spins and parities were deduced for some of the levels on the basis of DWBA double-stripping calculations. (auth)

38151 SPINS OF LEVELS IN ^{31}P AND ^{34}S. Moss, C. E. (Duke Univ., Durham, N. C. Triangle Universities Nuclear Lab., Durham, N. C.); Poore, R. V.; Roberson, N. R.; Tilley, D. R. Nucl. Phys.; A144: 577-92(1970).

The method II angular-correlation technique of Litherland and Ferguson was applied to the reactions ^{29}Si(α,pγ)^{32}P and ^{31}P(α,pγ)^{34}S. In ^{32}P the state at 1.755 MeV was determined to have J = 3. In ^{34}S the state at 4.07 MeV was determined to have J = 1, and the state at 4.89 MeV, J = 2. For other low-lying levels in ^{32}P and ^{34}S the present results are in agreement with the previously known spin assignments. Some mixing ratios and branching ratios were also determined. The γ-ray spectrum from the reaction ^{31}P(α,pγ)^{34}S was examined with a Ge(Li) detector to determine the excitation energies of the first nine excited states in ^{34}S and to assist in determining the branching ratios. As a by-product the excitation energies of the first three excited states in ^{34}Cl populated by the reaction ^{31}P(α,nγ)^{34}Cl were also determined. (auth)

38152 EFFECT OF PAIRING CORRELATIONS ON ^{22}Ne SPECTRUM. Gunye, M. R.; Khadkikar, S. B. (Tata Inst. of Fundamental Research, Bombay). Phys. Rev. Lett.; 24: 910-12(20 Apr 1970).

The effects of pairing correlations on the ground-state band of ^{22}Ne are investigated. It is shown that the computed low-lying excited-state spectrum is significantly affected, whereas the E2 transition probabilities are almost unaffected by the pairing correlations. (auth)

38153 THE REACTION ^{23}Na(p,p) IN THE RANGE 8.0 TO 12.0 MeV. III. ANALYSIS OF AVERAGE INELASTIC CROSS SECTIONS, FLUCTUATIONS, AND MODEL COMPARISONS. Hellstroem, J.; Dallimore, P. J.; Davidson, W. F. (Australian National Univ., Canberra). Nucl. Phys.; A144: 654-72(1970).

Proton elastic and inelastic cross sections were measured in the range 8.0 to 12.0 MeV. The results were analyzed using both the combined optical model, DWBA and Hauser–Feshbach theories and the theory of fluctuations. Predictions of the different models are compared and it is found that intermediate structure is interpreted differently by each model. However, after the effects due to the intermediate structure are taken into account, the agreement between the models is good. (auth)

38154 ADDITIONAL MEASUREMENTS OF THE RADIATIVE CAPTURE CROSS SECTIONS FOR 3-MeV NEUTRONS. Diksic, M. (Inst. Ruder Boskovic, Zagreb); Strohal, P.; Peto, G.; Bornemisza-Pauspertl, P.; Hunyadi, I.; Karolyi, J. Acta Phys. Acad. Sci. Hung.; 28: 257-61(1970).

The cross sections for ^{63}Cu, ^{74}Ge, ^{75}As, ^{80}Se, ^{81}Br, ^{130}Te, ^{141}Pr, ^{186}W, ^{209}Bi(n,γ) reactions were measured at 3 MeV. The results are in agreement with earlier measurements and follow the general trend observed in the radiative capture cross sections for fast neutrons. In the case of Ge, Se and Pr the isomeric cross-section ratios were also calculated on the basis of the Huizenga–Vandenbosh method. From a comparison of the calculated and measured isomeric ratios the probable value of the spin cut-off parameter and the inertia moment of the nucleus were deduced. (auth)

38155 EXCITATION FUNCTIONS FOR THE FORMATION OF ^{68}Ge, ^{65}Zn, AND ^{22}Na IN DEUTERON IRRADIATION OF GALLIUM AND ALUMINUM. Karpeles, Alfredo (Kernforschungszentrum, Karlsruhe, Ger.). Radiochim. Acta; 12: 212-13(Dec 1969). (In German).

For diagnostic purposes, ^{68}Ga is usually produced from its long-lived mother ^{68}Ge. To produce the mother product, natural gallium oxide of extreme purity was pressed into plates of 100 μm thickness. These targets were then exposed for 2 hours to a deuteron beam of the Karlsruhe isochronous cyclotron. After one month delay, activity of the ^{68}Ge was obtained. From the data, cross sections were obtained for the reactions: ^{69}Ga (d,3n), ^{69}Ga (d,α2n), ^{71}Ga (d,5n), and ^{71}Ga (d,α4n). At the maximum available deuteron energy of 50 MeV, a total of 37 μCi of ^{68}Ge per hour was produced. The corresponding target thickness was 1760 mg Ga_2O_3/cm^2. In addition, the excitation functions for ^{69}Ga (d,α2n) ^{65}Zn, and ^{27}Al (d, αp,2n) ^{22}Na were determined. (H.B.G.)

38156 PROPERTIES OF ^{63}Cu NEGATIVE PARITY STATES IN THE SEMIMICROSCOPIC MODEL. Paar, V. (Inst. Rudjer Boskovic, Zagreb. Univ. of Copenhagen). Nucl. Phys.; A147: 369-84(1970).

The semimicroscopic model assuming a proton coupled to a quadrupole vibrator, with states up to three phonons included, is applied to ^{63}Cu. Parametrization different from that by Bouten and Van Leuven is used. Blair's spectroscopic factors are well reproduced, and the experimentally known properties of B(E2) values are obtained. The influence of particle-hole excitations in the internal phonon structure within this parametrization appears to be small. The configuration $|(f_{\frac{5}{2}}^{-1}p_{\frac{3}{2}})2\rangle$ is a dominant proton excitation in the one-phonon state. (auth)

38157 LIFETIME MEASUREMENTS IN sd-SHELL NUCLEI. II. MEAN LIVES OF ^{33}S LEVELS. Van Middelkoop, G.; Engelbertink, G. A. P. (Univ., Utrecht). Nucl. Phys.; A138: 601-8 (1969).

Levels in ^{33}S were populated with the ^{32}S(d,p)^{33}S reaction at E_d = 5.00 MeV. Gamma rays were simultaneously measured in coincidence with protons at angles θ_p = 45° and −45° or 135° and −135°. From the coincidence Doppler shift attenuation measurements mean lives of $\tau_m = 1/30^{+110}_{-450}$, 150 ± 45, 140 ± 30, 13 ± 5, >7000, 86 ± 25 and 28 ± 9 fs were found for the ^{33}S levels at E_x = 0.84, 1.97, 2.31, 2.87, 2.94, 2.97 and 3.22 MeV, respectively. Calculations with MSDI shell-model wave functions and a fit of single-particle reduced matrix elements to experimentally known mean lives of neighboring nuclei, predict very well the measured mean lives, known branchings, and mixing parameters. (auth)

38158 EXCITATION FUNCTIONS FOR THE BOMBARDMENT OF ^{56}Fe WITH PROTONS. Jenkins, I. L.; Wain, A. G. (Atomic Energy Research Establishment, Harwell, Eng.). J. Inorg. Nucl. Chem.; 32: 1419-25(May 1970).

In the production of ^{56}Co by the irradiation of ^{56}Fe with protons a number of other products may be formed, depending on the energy of the bombarding particle. Excitation functions for the proton bombardment of ^{56}Fe are given for the energy range from 4.9 to 39 MeV. (auth) (UK)

38159 STUDY OF NEUTRON ELASTIC SCATTERING IN 0.3 TO 4.1 MeV ENERGY REGION ON Ti AND Cr NUCLEI USING NUCLEAR OPTICAL MODEL. Pasechnik, M. V.; Korzh, I. A.; Kashuba, I. E.; Mishchenko, V. A.; Pravdyvi, N. M.; Sanzhur, I. E. (Inst. of Physics, Kiev). Yadern. Fiz.; 11: 958-66(May 1970). (In Russian).

Experimental data on the angular distributions of neutrons elastically scattered on Ti and Cr nuclei and on polarizability of these nuclei for eight values of 0.3 to 4.1 MeV neutron energy are analyzed in terms of the nuclear optical model. Theoretical calculations are performed on the basis of the nuclear optical model using the potential as

$$V(r) = -V_0 f(r) - iW_0 f(r) + V_{so}\left(\frac{\hbar}{\mu_\pi c}\right)^2 \frac{1}{r}\frac{d}{dr} f(r)\sigma l.$$

The functions $f(r)$ and $g(r)$ are taken in the Woods–Saxon and Gaussian form, respectively. The calculated data are fitted to the experimental ones by the least-squares method with automatic variation of two (V_c, W_c), three (V_c, W_c, a), and four (V_c, W_c, V_{so}, a) parameters of the potential. Variation of the potential parameters with the energy is discussed. (auth)

38160 γ-RAY SPECTRA RESULTING FROM CAPTURE OF THERMAL NEUTRONS BY ^{64,66,67,68}Zn NUCLEI. Barchuk, I. F.; Bazavov, D. A.; Belykh, G. V.; Golyshkin, V. I.; Murzin, A. V.; Ogorodnik, A. F. (Inst. of Physics, Kiev). Yadern. Fiz.; 11: 934-41(May 1970). (In Russian).

The hard part of γ-ray spectra resulting from the capture of thermal neutrons by ^{64,66,67,68}Zn isotopes was studied using the semiconductor Ge(Li) detector. Energies and intensities of γ-lines within the γ-spectra range measured are determined. Transition schemes are compiled based on the data obtained. Strong discrepancy is found between the values of spectroscopic factors for p levels observed in the reaction (d,p) and the probability of E1 transitions from the capture state to these levels in the (n,γ) reaction. It is found in ^{65}Zn that the most intense transitions from the capture state are those to the levels which are absent in the other reactions. (auth)

38161 SCATTERING OF MEDIUM-ENERGY ALPHA PARTICLES. III. ANALYSIS OF ELASTIC AND INELASTIC SCATTERING FROM ^{42}Ca AND ^{50}Ti. Morgan, C. G.; Jackson, Daphne F.

(Univ. of Surrey, Guildford, Eng.). Phys. Rev.; 188: 1758-64 (20 Dec 1969).

A combined analysis was made of elastic and inelastic scattering of medium-energy α particles from ^{42}Ca and ^{50}Ti. This is first done in terms of the generalized optical model. A conventional distorted-wave Born-approximation inelastic scattering is then made, using phenomenological optical potentials to generate the distorted waves, but using a microscopic description of the nuclear excitation constructed from an effective two-body interaction and shell-model wave functions for the nucleus. Finally, a fully microscopic calculation is made to give a consistent description of the elastic and inelastic scattering, and it is shown that this model is capable of producing results which are comparable, in terms of quality of fit to the data, to those given by the generalized optical model. (auth)

38162 NEUTRON ACTIVATION CROSS SECTIONS AT 14.8 MeV FOR RUBIDIUM, STRONTIUM, ZIRCONIUM, AND NIOBIUM. Husain, L.; Bari, A.; Kuroda, P. K. (Univ. of Arkansas, Fayetteville). Contract AT(40-1)-3235. Phys. Rev., C; 1: 1233-6(Apr 1970).

The activation cross sections for 18 (n,p), (n,α), and (n,2n) reactions are measured with 14.8-MeV neutrons. The radioactivity measurements are carried out with a Ge(Li) detector. The cross sections measured, in millibarns, are ^{27}Al(n,p)^{27}Mg, 73 ± 5; ^{85}Rb(n,2n)^{84m}Rb, 714 ± 50; ^{85}Rb(n,2n)^{84g}Rb, 621 ± 75; ^{85}Rb(n,p)^{85m}Kr, 6 ± 1; ^{87}Rb(n,2n)^{86m}Rb, 584 ± 40; ^{87}Rb(n,2n)^{86g}Rb, 833 ± 60; ^{87}Rb(n,p)^{87}Kr, 7 ± 1; ^{84}Sr(n,2n)^{83}Sr, 395 ± 75; ^{86}Sr(n,2n)^{85m}Sr, 360 ± 30; ^{86}Sr(n,p)^{86m}Rb, 9 ± 1; ^{88}Sr(n,2n)^{87m}Sr, 344 ± 30; ^{88}Sr(n,p)^{88}Rb, 20 ± 2; ^{90}Zr(n,2n)^{89m}Zr, 143 ± 15; ^{90}Zr(n,2n)^{89g}Zr, 342 ± 25; ^{90}Zr(n,p)^{90m}Y, 13 ± 1; ^{90}Zr(n,α)^{87m}Sr, 4.6 ± 0.5; ^{93}Nb(n,2n)^{92m}Nb, 455 ± 25; and ^{93}Nb(n,α)^{90m}Y, 5.8 ± 0.5. The measured cross sections are compared with those calculated by evaporation theory. The (n,2n) measured cross sections agree well with the calculated values but the agreement between calculated and measured values for (n,p) reactions is poor. (auth)

38163 GAMMA RAYS FOLLOWING RESONANT NEUTRON CAPTURE IN ^{56}Fe. Chrien, R. E.; Bhat, M. R.; Wasson, O. A. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., C; 1: 973-5(Mar 1970).

The spectrum of γ rays following neutron capture at the 1167-eV resonance in ^{56}Fe is measured at 90 and 135° to the incident beam. The partial widths for radiative decay are determined and compared to the Weisskopf estimates. The M1 and E1 γ-ray strengths are found to be comparable, and a sizable E2 γ ray in the resonance is recorded. On the basis of the γ-ray measurements at two angles, and from what has been determined from other experiments, the spin and parity of the 1167-eV resonance are shown to be $\frac{1}{2}^-$. (auth)

38164 NUCLEAR STRUCTURE OF ^{22}Na. VI. SOME RESULTS FOR LEVELS WITH $E_{ex} > 2.9$ MeV. Olness, J. W.; Harris, W. R.; Paul, P.; Warburton, E. K. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., C; 1: 958-73(Mar 1970).

Further studies of the ^{20}Ne(^{3}He,p)^{22}Na reaction are carried out to investigate in particular those ^{22}Na states of excitation energy greater than 2.9 MeV. From a measurement of the linear polarization of γ rays from ^{22}Na states formed in the above reaction, it is determined that the 3-MeV doublet states at 2.969 MeV (J = 3) and 3.059 (J = 2) both have even parity. The γ decays of higher-lying states are investigated through p-γ coincidence measurements which utilized a 30-cc Ge(Li) spectrometer for γ detection. Correlation results lead to a $J^\pi = 3^-$ assignment for the 3.521-Mev state. The p-γ measurements also determine the principal γ decay of 9 of the 13 states previously reported in the region 4 MeV < E_{ex} < 5.2 MeV. Some information is also obtained on the spins of these states. Evidence is presented for the decay of a previously unreported level at an excitation energy of 4.294 ± 0.002 MeV. (auth)

38165 BETA DECAY OF ^{25}Na AND ^{29}Al. Jones, A. D. W.; Becker, J. A.; McDonald, R. E.; Poletti, A. R. (Lockheed Palo Alto Research Lab., Palo Alto, Calif.). Phys. Rev., C; 1: 1000-8(Mar 1970).

The β-decay modes of ^{25}Na and ^{29}Al are studied by observation of delayed γ rays with a Ge(Li) γ-ray spectrometer system. The nuclei are produced via the ^{22}Na(t,p)^{25}Na and ^{27}Al(t,p)^{29}Al reactions, respectively, at the incident triton energy of 2.7 MeV. For ^{25}Na, the previously reported β branches to the 0.975- and 1.612-MeV states of ^{25}Mg are confirmed, while new branches are found to the states at 1.965 and 2.801 MeV. Decay modes (labeled by the final-state energy in ^{25}Mg) and their relative intensities, assuming a ground-state branch of 65%, are 0.975 MeV, 25.5%; 1.612 MeV, 8.8%; 1.965 MeV, 0.4%; and 2.801 MeV, 0.3%. Accurate excitation energies in ^{25}Mg deduced from the γ-ray pulse-height distribution are (in keV) 585.9 ± 0.4, 975.3 ± 0.3, 1612.0 ± 0.4, 1965.2 ± 0.9, and 2801.0 ± 0.7. In the decay of ^{29}Al, previously reported branches to the 1.273- and 2.427-MeV states of ^{29}Si are confirmed, while a new branch is reported to the state at 2.028 MeV. Assuming zero ground-state branching, the decay modes with their relative intensities are 1.273 MeV, 89.1%; 2.028 MeV, 4.1%; and 2.426 MeV, 6.8%. The state at 3.069 MeV is populated with an intensity ≤0.1%. Excitation energies in keV of 1273.2 ± 0.8, 2028.2 ± 0.8, and 2426.3 ± 0.8 are obtained for these states in ^{29}Si. For both nuclei, experimentally observed log ft values are compared with nuclear-model predictions. An adequate description of the ^{25}Na β decay in terms of the Nilsson model is obtained by introducing mixing of the two K = ½ bands based on neutrons in orbits 9 and 11 in ^{25}Mg. The $J^\pi = \frac{1}{2}^+$ states of these bands are at 0.586 and 2.562 MeV, respectively. The collective-model interpretation of ^{29}Si is strengthened by the observation of a β branch to the 2.028 MeV level in ^{29}Si; quantitative agreement, however, with the ^{29}Al β-decay modes can not readily be obtained using the Nilsson-model wave functions. Possible spherical-shell-model configurations to explain the decay modes are suggested. The β-decay strengths deduced from these observations for ^{25}Na and ^{29}Al are compared with analogous γ-ray strengths observed in ^{25}Al and ^{29}P, respectively. (auth)

38166 SCATTERING OF 14.5-MeV PROTONS FROM THE EVEN ISOTOPES OF GERMANIUM. Curtis, T. H.; Lutz, H. F.; Bartolini, W. (Univ. of California, Livermore). Phys. Rev., C; 1: 1418-31(Apr 1970).

Protons from the 90-in. cyclotron at Lawrence Radiation Laboratory (LRL)–Livermore are scattered from enriched targets of ^{70,72,74,76}Ge, with an overall energy resolution (FWHM) of 70 keV. The incident proton energy is approximately 14.5 MeV, and angular distributions are obtained from 20 to 150°, in 10° intervals. The elastic-scattering results are analyzed using the optical model. Angular distributions are obtained for inelastic proton groups from seven levels in ^{70}Ge, nine levels in ^{72}Ge, eleven levels in ^{74}Ge, and ten levels in ^{76}Ge—all below 3.5-MeV excitation. These include scattering to the quadrupole and octupole one-phonon vibrational levels and scattering to the 0^+, 2^+, 4^+ two-quadrupole–phonon triplet. The data are analyzed using a coupled-channel computer code and a vibrational model of the nucleus. Strengths to excited states (β_l) and spins and parities of levels are determined and are compared with Coulomb-excitation decay studies and with other scattering experiments. (auth)

38167 GAMMA-RAY SPECTRA OF ^{64}Cu AND ^{66}Cu FOLLOWING RESONANT-NEUTRON CAPTURE. Stein, W. E. (Los Alamos Scientific Lab., N. Mex.); Thomas, B. W.; Rae, E. R. Phys. Rev., C; 1: 1468-76(Apr 1970).

γ-ray spectra following thermal- and resonant-neutron capture in copper are studied using the Harwell electron linear accelerator and a lithium-drifted germanium detector. The energy resolution of the γ-ray spectrometer is about 14 keV over the neutron energy range from thermal to 2.7 keV. In addition to a thermal-neutron spectrum taken with a natural copper sample, the data include capture-γ-ray spectra for the 0.577-, 2.06-, and 2.66-keV resonances in ^{63}Cu(n,γ)^{64}Cu, and the 0.229-keV resonance in ^{65}Cu(n,γ)^{66}Cu. An analysis of the strengths of 91 assumed E1 transitions in the ^{63}Cu(n,γ)^{64}Cu resonant data gave a best fit to a χ^2 function with 1.0 ± 0.2 degrees of freedom. The intensities of the four highest-energy transitions in the same reaction are observed to decrease by more than a factor of 6 as the neutron energy increases from thermal to 2.66 keV. A number of strong transitions approximately 3 MeV below the neutron binding energy is observed in the first resonance of both isotopes. Tentative spin assignments are given for the 0.229-keV resonance in ^{66}Cu. If the resonance is due to capture of s-wave neutrons, the spin and parity are 2^-. For capture of neutrons with higher partial waves, the spin is restricted to either 2 or 3 with the parity determined by the relative orbital angular momentum. (auth)

38168 STUDY OF THE (d,t) REACTION ON ^{28}Si, ^{32}S, AND ^{36}Ar. Whitten, C. A. Jr.; Mermaz, M. C.; Bromley, D. A. (Yale Univ., New Haven). Contract AT(30-1)-3223. Phys. Rev., C; 1: 1455-67(Apr 1970).

The ^{28}Si(d,t)^{27}Si reaction and the ^{32}S(d,t)^{31}S and ^{36}Ar(d,t)^{35}Ar reactions are studied at deuteron energies of 21.6 and 21.0 MeV, respectively. Angular distributions are obtained for triton groups from these (d,t) reactions leading to levels in the residual nuclei ^{27}Si, ^{31}S, and ^{35}Ar with excitation energies up to approximately 3.5 MeV. Spectroscopic factors for the strong (d,t) transitions are extracted using now standard distorted-wave Born-approximation (DWBA) analyses. The (d,t) spectroscopic factors from this work are in reasonable agreement with previous neutron-pickup experimental data on ^{28}Si, ^{32}S, and ^{36}Ar, whenever the latter are available. Recent 2s-1d shell-model calculations are in reasonable

accord with these data. In the particular case of the $^{36}Ar(d,t)^{35}Ar$ data, it appears that the theoretical calculation which uses a "realistic" interaction derived from nucleon-nucleon scattering gives better agreement with these data than the theoretical calculation which uses a modified surface δ interaction. (auth)

38169 STUDIES ON THE LOW-LYING LEVELS OF ^{24}Ne. Howard, A. J. (Yale Univ., New Haven); Hirko, R. G.; Bromley, D. A.; Bethge, K.; Olness, J. W. Contract AT(30-1)-3223. Phys. Rev., C; 1: 1446-55(Apr 1970).

Angular-distribution measurements are performed on the $^{22}Ne(t,p)^{24}Ne$ reaction at $E_t = 3.3$ MeV. Formation of the ground and 4.76-MeV ^{24}Ne states is characterized by l = 0 transfer, which establishes $J^\pi = 0^+$ for these two states. The J = 2, 3.87-MeV state is observed to be formed via l = 2 transfer, and so even parity is indicated for this state. Proton-γ angular-correlation experiments are carried out in method II geometry at $E_t = 3.45$ and 3.33 MeV. These results establish unambiguous J = 4 and 2 assignments for the respective 3.96- and 5.58-MeV levels of ^{24}Ne. The present experimental information on the static properties of ^{24}Ne is shown to be consistent with a j-j coupling-model representation involving pure two-body proton configurations. An intercomparison of the observed static properties associated with the low-lying levels of the even-A neon isotopes is presented, and a remarkable similarity is shown to exist between the low-lying level structures of ^{18}O and ^{24}Ne. It is concluded that $1d_{\frac{5}{2}}$ subshell closure effects underlie the ^{24}Ne spectrum. (auth)

38170 TOTAL NEUTRON CROSS SECTIONS OF GROSS FISSION PRODUCTS. Sulitze, H.; Jung, H. H. (Univ., Kiel). Atomkernenergie; 15: 189-98(1970). (In German).

Total neutron cross sections of gross fission products in the energy range from 1 to 1000 eV are examined. It is assumed that these fission products have been produced by irradiating an U-235 sample in a nuclear reactor. Energy-dependent total neutron cross sections of 195 fission products are calculated by means of the Breit-Wigner formula from resonance parameters, which are generated in a Monte Carlo computation, making use of the well-known statistical properties of resonance parameters of medium heavy nuclei. The correspondent concentrations of the fission products are calculated with a zero-dimensional, two group burnup program as function of neutron flux (thermal and fast), burnup and time after shutdown. It is shown that only two to three percent of 16,700 resonances which are generated in the energy range mentioned have peaks well above the cross section in between these resonances. The influence of the parameters neutron flux, burnup, and time after shutdown are discussed. From the results, conclusions are made for the resolution characteristics of an apparatus for measuring total neutron cross sections of gross fission products. The results do not predict the true cross sections but they show how they will be in principle. (auth)

38171 LEVEL STRUCTURE OF ^{55}Co, ^{51}V, AND ^{49}V FROM γ-DECAY. Mo, J. N.; Cujec, B.; Dayras, R.; Szoeghy, I. M.; Toulemonde, M. (Laval Univ., Quebec). Nucl. Phys.; A147: 129-42(1970)

Gamma rays following $^{54}Fe(^3He,d)^{55}Co$, $^{50}Ti(^3He,d)^{51}V$, $^{48}Ti(\alpha,p)^{51}V$, and $^{46}Ti(\alpha,p)^{49}V$ reactions were measured. Branching ratios were deduced for levels in ^{55}Co up to 4.185 MeV, in ^{51}V up to 2.699 MeV, and in ^{49}V up to 2.409 MeV. On the basis of the decay schemes and previously established l-values, the following J^π assignments were made: ^{55}Co 2.162 MeV, $\frac{1}{2}^-$; 2.559 MeV, $\frac{3}{2}^-$; 2.938 MeV, $\frac{1}{2}^-$; ^{51}V 2.410 MeV, $\frac{3}{2}^-$; ^{49}V 1.141 MeV, $\frac{5}{2}^-$; 2.234 MeV, $\frac{3}{2}$ or $\frac{5}{2}$. The $\frac{1}{2}^+$ states in ^{51}V (at 2.547 MeV) and in ^{49}V (at 1.646 MeV) were observed to decay predominantly to the lowest $\frac{3}{2}^-$ state. This indicates some admixture to the main component of the $\frac{1}{2}^+$ state, which gives rise to the E1 transition. (auth)

38172 PRECISE MEASUREMENT OF THE HALF-LIFE OF ^{45}Ca. Hansen, James W.; Prussin, Stanley G. (Univ. of California, San Francisco). Int. J. Appl. Radiat. Isotop.; 21: 335-8 (Jun 1970).

The half-life of ^{45}Ca was determined by scintillation counting to be 8.715 ± 0.023 min. Sample purity and stability of the counting electronics have been carefully examined to ensure minimization of systematic errors in the measurements. As a further check, the half-life of ^{27}Mg was measured and found to be in close agreement with results reported in the literature. (auth) (UK)

38173 MAGNITUDE OF THE ^{51}V NUCLEAR ELECTRIC QUADRUPOLE MOMENT. Bennett, Robert A.; Hooper, H. O. (Wayne State Univ., Detroit). J. Chem. Phys.; 52: 5485-6 (15 May 1970).

From a comparison of the quadrupole perturbation to the NMR of ^{51}V and ^{93}Nb nuclei in VBe_{12} and $NbBe_{12}$, it is concluded that the nuclear electric quadrupole moment Q of ^{51}V is probably ~0.05 b. (D.L.C.)

38174 STUDIES CONCERNING THE DECAY SCHEMES OF CERTAIN NUCLEI. Berenyi, Denes. ATOMKI (At. Kut. Intez.) Kozlem.; 11: 81-110(Nov 1969). (In Hungarian).

Studies carried out at the Division of Nuclear Spectroscopy of the Debrecen Nuclear Research Institute are summarized. They include investigations by semiconductor γ spectrometry to clarify decay schemes, such as the determination of the γ-radiation energy and relative intensity in the decay of ^{27}Mg(9.5 min) for the study of the excited levels of ^{27}Al. The transition region was investigated by determining the decay schemes of ^{145}Sm and ^{144}Pm. Internal conversion measurements were made to determine the multipolarity of the 742-keV transition in the decay scheme of ^{143}Pm by means of a toroidal-sector type β spectrometer. The 0.337-1.10 MeV cascade of ^{59}Fe was used for $\gamma-\gamma$ angular correlation measurements, using the sum-correlation technique. The low-intensity, positive β decay after branching was investigated by searching for positrons in the decay of ^{143}Pm, ^{144}Pm and ^{146}Pm. The upper limit of the presence of positrons in the decay of ^{54}Mn was determined by studying the energetically permitted-β^+ decay in the $^{54}Mn-^{54}Cr$ transition. (Review article, 103 references). (TTT)

38175 ENERGY LEVELS OF ^{20}F UP TO 6.043-MeV EXCITATION. Rollefson, A. A.; Jones, P. F.; Shea, R. J. (Univ. of Notre Dame, Ind.). Phys. Rev., C; 1: 1761-6(May 1970).

The reactions $^{18}O(^3He,p)^{20}F$ and $^{19}F(d,p)^{20}F$ were used to study levels in ^{20}F up to an excitation energy of 6.043 MeV. The energies of the reaction protons were measured with a broad-range magnetic spectrograph. Excitation energies were obtained for 45 levels in ^{20}F. The ground-state Q values for the above reactions were also measured and found to be 6.8752 ± 0.0015 MeV for the $^{18}O(^3H,p)^{20}F$ reaction and 4.3777 ± 0.0009 MeV for the $^{19}F(d,p)^{20}F$ reaction. (auth)

38176 NUCLEAR SPIN-SPIN EFFECT IN THE TOTAL CROSS SECTION FOR 1 MeV POLARIZED NEUTRONS ON POLARIZED ^{59}Co NUCLEI. Nagamine, Kanetada; Uchida, Akira; Kobayashi, Shinsaku (Tokyo Univ.). Nucl. Phys.; A145: 203-22(1970).

Measurements of the spin-spin effect, $\sigma_{ss} = (\sigma\uparrow\uparrow - \sigma\uparrow\downarrow)/2P_n \cdot P_t$ in the total cross section for polarized neutrons on polarized ^{59}Co are reported at neutron energies of 1.1 and 1.4 MeV. Target polarizations from 47 ± 5% to 30 ± 3% were obtained for a polycrystalline metal of $Co_{0.90}$-$Fe_{0.10}$ alloy at demagnetization temperatures from 0.030 to 0.048°K. The results for σ_{ss} are −0.21 ± 0.18 b at 1.1 MeV and −0.18 ± 0.23 b at 1.4 MeV, combined with experimental asymmetries obtained at 4.2°K. If σ_{ss} is assumed to arise from a spin-spin term in the optical potential of the form $-V_{ss}f(r)\sigma \cdot I$, the upper limit of the strength is obtained as $|V_{ss}| < 1.0$ MeV, combining with the published data for σ_{ss} at 7.90 MeV and assuming $f(r)$ as a microscopic form factor. The obtained nature of V_{ss} is qualitatively explained by a microscopic model. (auth)

38177 THE STRUCTURE OF ^{36}Ar AND ^{38}Ar VIA THE (^3He,d) REACTION ON ^{35}Cl AND ^{37}Cl. Moinester, M. A.; Alford, W. Parker (Univ. of Rochester, N. Y.). Nucl. Phys.; A145: 143-76(1970).

The level structures of ^{36}Ar and ^{38}Ar were investigated with the $^{35,37}Cl(^3He,d)^{36,38}Ar$ reactions at a bombarding energy of 12 MeV. Deuteron angular distributions were measured for 31 levels in ^{36}Ar up to 8.5 MeV excitation and 29 levels in ^{38}Ar up to 6.9 MeV excitation. The l_p values and transition strengths were determined from a distorted wave Born analysis of the angular distributions. The results for the positive parity states of ^{36}Ar and ^{38}Ar are in reasonable agreement with a shell-model calculation which considers only $1d_{\frac{5}{2}}$ and $2s_{\frac{1}{2}}$ nucleons outside a closed ^{28}Si core. The major components of the $(f_{\frac{7}{2}}\, d_{\frac{3}{2}}^2)_{T=1}$ configuration in ^{38}Ar for $J^\pi = (3, 4, 5)^-$ and of the $(f_{\frac{7}{2}}\, d_{\frac{3}{2}}^2)_{T=0}$ configuration in ^{36}Ar for $J^\pi = (3, 5)^-$ were identified. For the $f_{\frac{7}{2}}$ transitions in ^{38}Ar, and to a lesser extent in ^{36}Ar, the observed severe fragmentation of strength shows that a model involving core polarization rather than a simple weak coupling model is applicable in describing the structure of these nuclei. All the $p_{\frac{3}{2}}$ transition strength to $T_<$ states was accounted for in ^{36}Ar but only 12% in ^{38}Ar. It appears that the $p_{\frac{3}{2}}$-$f_{\frac{7}{2}}$ single-particle energy splitting is significantly smaller in ^{39}Ar than in ^{38}Ar. The angular distributions of all known 3^- states are consistent with mixed $l = 1 + 3$ transitions, showing that configuration admixtures between the $(p_{\frac{3}{2}}\, d_{\frac{3}{2}}^2)$ and $(f_{\frac{7}{2}}\, d_{\frac{3}{2}}^2)$ configurations are important. (auth)

38178 SPIN ASSIGNMENTS OF STATES IN ^{24}Mg FROM AN ANALYSIS OF DOPPLER-BROADENED GAMMA RAYS. Stark, W. J.; Cockburn, P. M.; Krone, R. W. (Univ. of

Kansas, Lawrence). Contract AT(11-1)-1120. Phys. Rev., C; 1: 1752-6(May 1970).

The spins of the ^{24}Mg states at 12.74-, 12.85-, and 12.97-MeV excitation, which are populated in the ^{22}Na(p,$\alpha\gamma$)^{20}Ne reaction, were determined to be 2^+, 2^-, and 2^-, respectively, from α-γ correlation measurements. The correlation is measured simply by observing the 1.63-MeV γ ray at 0°, and analyzing the γ-ray line shape in terms of the possible spins of the ^{24}Mg states. (auth)

38179 ISOBARIC ANALOG RESONANCES IN THE ^{68}Zn(p,n)^{68}Ga REACTION FROM 4 TO 5 MeV. Egan, J. J.; Dutt, G. C.; McPherson, M.; Gabbard, F. (Univ. of Kentucky, Lexington). Phys. Rev., C; 1: 1767-75(May 1970).

Two pairs of isobaric analog resonances near 4.1- and 4.9-MeV proton bombarding energy, respectively, were studied in the ^{68}Zn (p,n)^{68}Ga reaction. Differential cross sections were measured at 2.5, 30, and 130° for neutrons which leave ^{68}Ga in the ground state and 180-keV first excited state in the bombarding energy region from 4.00 to 4.15 MeV. Analog resonances at 4.075 and 4.098 MeV were analyzed according to the Robson theory. Eleven levels in ^{68}Ga up to an excitation energy of 1.088 MeV were identified in time-of-flight spectra. Hauser-Feshbach analyses were done on the angular distributions of neutrons leaving ^{68}Ga in 4 and 6 residual nucleus states at 4.400 and 4.512 MeV, respectively, an energy region where no analog resonances appear. Excitation functions for seven neutron groups were measured at 100° in the bombarding energy region 4.7 to 5.0 MeV, where two analog resonances, at 4.87 and 4.92 MeV, were seen. An analysis according to the theory of Robson was performed on these resonances in order to obtain spins, parities, and resonance parameters. (auth)

38180 CROSS SECTIONS AND ISOMER RATIOS FOR THE ^{45}Sc(^{3}He,α)^{44m,44g}Sc REACTIONS FROM 6 TO 19 MeV: RECOIL-RANGE STUDIES FOR ^{44m}Sc AND ^{44g}Sc IN ^{45}Sc. Riley, Clyde (Univ. of Alabama, Huntsville. Florida State Univ., Tallahassee). Contract AT(40-1)-2628. Phys. Rev., C; 1: 1776-81(May 1970).

The absolute cross sections for the production of ^{44m}Sc and ^{44g}Sc (^{3}H,α) reaction were determined at 1-MeV intervals from 6–19 MeV. The experimentally determined isomer-ratio function has only a limited variance over the energy range studied. Calculations of the Huizenga-Vandenbosch type were performed. Spin cutoff parameters of 2 and 4 gave poor fits of the isomer data. Recoil ranges for ^{44m}Sc and ^{44g}Sc in ^{45}Sc were determined. Recoil energies for ^{44}Sc were calculated assuming (1) a compound-nucleus mechanism and (2) a pickup-type mechanism. Recoil ranges for ^{44}Sc in ^{45}Sc were then calculated using the formulation of Lindhard, Scharff, and Schiott. Comparison of the experimental recoil ranges with the calculated values resulted in poor agreement with both calculations. The inability to fit the isomer-ratio data with a spin cutoff parameter of 2, and the poor agreement of the experimental recoil ranges with the compound-nucleus-mechanism calculation, are interpreted as evidence for the occurrence of non-compound-nucleus-type processes. (auth)

38181 SHELL-MODEL CONTINUUM IN NUCLEAR BOUND STATES. Ibarra, R. H.; Bayman, B. F. (Univ. of Minnesota, Minneapolis). Phys. Rev., C; 1: 1786-1800(May 1970).

Shell-model calculations are performed for bound 0^+ states of ^{42}Ca and ^{58}Ni. The neutron configurations $1f_{\frac{5}{2}}$, $2p_{\frac{3}{2}}$, $2p_{\frac{1}{2}}$, $1f_{\frac{7}{2}}$, and $1g_{\frac{9}{2}}$ are included, as well as states in which one of the neutrons is in the shell-model continuum. These continuum contributions have little effect on energy eigenvalues, but modify the wave functions in the vicinity of the nuclear surface. The calculated wave functions yield one-particle-transfer form factors whose logarithmic derivatives at large radius are consistent with the neutron separation energies. Comparison is made with other procedures for calculating form factors within the framework of the ordinary shell model. It is found that the conventional well-depth procedure underestimates the (p,d) cross sections for populating highly excited states, relative to low-lying states, by about 50%. Two-neutron-transfer cross sections are also calculated and are found to be in agreement with those yielded by the well-depth procedure. However, some of the form factors exhibit an extra node at 8 F, showing that they do not decay like a Hankel function. (auth)

38182 ELECTRON CAPTURE TO 2^+ LEVEL IN NUCLEI ^{72}As, ^{74}As, ^{84}Rb. Kopytin, I. V.; Batkin, I. S. (Voronezh State Univ., USSR). Yadern. Fiz.; 11: 533-6(Mar 1970). (In Russian).

Numerical calculations of the coefficients ϵ_K/β^+ and ϵ_L/ϵ_K for the transitions $2^- \rightarrow 2^+$ in nuclei ^{72}As, ^{74}As, ^{84}Rb are fulfilled on basis of the exact expressions. The obtained results are compared with experiment as well as with some approximate approaches. (auth)

38183 MEAN LIVES OF THE FIRST TWO EXCITED STATES IN ^{34}S. Brandolini, F.; Signorini, C. (Univ., Padua. Istituto Nazionale di Fisica Nucleare, Padua. Laboratori Nazionali di Legnaro, Padua). Nuovo Cim.; 67A: 247-56 (21 May 1970).

The mean lives of the excited states of ^{34}S at 2.13 and 3.30 MeV were found to be (460 ± 95) and (190 ± 40) fs, respectively, using the DSAM on the ^{31}P(α,pγ)^{34}S reaction. The usual method of attenuation coefficient and a new method were applied in order to deduce mean lives from experimental data. Experimental results are compared with the predictions of the MSDI calculations. (auth)

38184 MEASUREMENT OF THE BETA SPECTRUM SHAPE OF ^{89}Sr. Wohn, F. K.; Talbert, W. L. Jr. (Ames Lab., Iowa). Nucl. Phys.; A146: 33-42(1970).

The spectrum shape of the first-forbidden unique β-decay of ^{89}Sr was measured with the high-resolution $\pi\sqrt{2}$ magnetic spectrometer of the TRISTAN on-line isotope separator system. The β-spectrum shape was analyzed using the electron radial wave functions (ERWF) tabulation of Bhalla and Rose. A method is presented for accurate linear interpolation of tabulated ERWF which includes corrections for screening by atomic electrons. The observed deviation from the theoretical first-forbidden unique spectrum shape can be represented by a shape correction factor 1 + b/W with b = 0.049 ± 0.007. The end-point energy was found to be 1.488 ± 0.004 MeV. (auth)

38185 ENERGY LEVELS IN ^{56}Co. Erlandsson, B.; Marcinkowski, A. (Univ. of Lund, Sweden). Nucl. Phys.; A146: 43-61(1970).

^{57}Fe was bombarded with protons, and 114 peaks in the yield curve for the reaction ^{57}Fe(p,γ)^{58}Co were observed in the range of proton energy from 1175 to 1675 keV. Gamma-ray measurements were performed with a Ge(Li) detector and the decay scheme studied with a coincidence spectrometer. A decay scheme with 30 excited levels and 52 transitions is proposed. The excited states are discussed and compared with shell-model calculations. The integrated experimental spectrum of primary gamma rays has been compared with the statistical primary gamma-ray spectrum. (auth)

38186 ELASTIC ELECTRON SCATTERING ON $^{58\ 60\ 64}$Ni AND $^{112\ 116}$Sn ISOTOPES. Khvastunov, V. M.; Afanas'ev, N. G.; Afanas'ev, V. D.; Gulkarov, I. S.; Omelaenko, A. S.; Savitskii, G. A.; Khomich, A. A.; Shevchenko, N. G.; Romanov, V. S.; Rusanova, N. V. (Physical-Technical Inst., Kharkov). Nucl. Phys.; A146: 15-25(1970).

Absolute measurements were performed for the elastic scattering of 225-MeV electrons on ^{58,60,64}Ni and ^{112,116}Sn isotopes. The experimental results were analyzed using the high-energy approximation for the Fermi-type charge-density distribution. The derived rms radii show a correlation between the change of the charge radius of the isotopes and the orbital momenta (or neutron subshell filling) of the added neutrons. The radii, deduced from the transition energies of muonic atoms, turn out to be smaller. Agreement between the two experiments may be reached under the assumption that the charge density has a pronounced maximum in the central region of the ^{58}Ni nucleus and is less pronounced for ^{116}Sn. (auth)

38187 MEASUREMENT OF THE LIFETIMES OF THE FIRST EXCITED STATES OF ^{28}Si. Aleonard, M. M.; Castera, D.; Hubert, P.; Leccia, F.; Mennrath, P.; Thibaud, J. P. (Univ., Bordeaux). Nucl. Phys.; A146: 90-8(1970). (In French).

The lifetimes of eleven levels in ^{28}Si were measured with the Doppler shift attenuation method. The states were excited in the ^{27}Al(p,γ)^{28}Si reaction. A decay scheme is given for the resonance at E_p = 774 keV. The levels at 8.947 and 10.430 MeV were populated at the E_p = 2054 keV resonance. The results are compared with rotational-model and Hartree–Fock calculations. (auth)

38188 POLARIZATION IN THE ELASTIC SCATTERING OF 12 MeV DEUTERONS. Griffith, J. A. R.; Irshad, M.; Karban, O., Roman, S. (Univ. of Birmingham, Eng.). Nucl. Phys.; A146: 193-214(1970).

Angular distributions are presented of the vector polarization of 12-MeV deuterons elastically scattered by Si, ^{52}Cr, ^{56}Fe, ^{58}Ni, ^{93}Nb, Ag and In. Large values of polarization were observed for Si, ^{52}Cr, ^{56}Fe, and ^{58}Ni. The polarization diffraction pattern was seen to decrease systematically with Z up to silver but was found to increase for indium. The measurements were analyzed in terms of an optical model which accounted for most of the results including those of Ag and In. Average sets of optical-model parameters have been found. The A and Z dependence of some parameters has been investigated. (auth)

38189 NEUTRON SCATTERING FROM VANADIUM AT 1.5 TO 8 MeV. Holmqvist, B.; Johansson, S. G.; Lodin, G.; Wiedling,

T. (Neutron Physics Lab., Studsvik, Sweden). Nucl. Phys.: A146: 321-36(1970).

Fast neutron scattering interactions with vanadium were studied using time-of-flight techniques at several energies in the interval 1.5 to 8.1 MeV. The experimental differential elastic scattering cross sections have been fitted to optical-model calculations and the inelastic scattering cross sections have been compared with Hauser–Feshbach calculations, corrected for the fluctuation of compound nuclear level widths. (auth)

38190 THERMAL NEUTRON CAPTURE γ-RAY SPECTRA FOR ^{70}Ge, ^{72}Ge, ^{74}Ge. Barchuk, I. F.; Bazavov, D. A.; Belykh, G. V.; Golyshkin, V. I.; Murzin, A. V.; Ogorodnik, A. F. (Inst. of Physics, Kiev). Ukr. Fiz. Zh.; 15: 245-50(Feb 1970). (In Russian).

The hard parts of the thermal neutron capture γ-ray spectra for ^{70}Ge, ^{72}Ge, ^{74}Ge were measured, using a Ge(Li) spectrometer. The transitions for ^{71}Ge, ^{73}Ge, ^{75}Ge were plotted on the basis of the measured energy and intensities of γ-lines. A large discrepancy is found between the probability of the E1-transitions from the capture state in the (n,γ)-reaction and the probability of excitation of the corresponding levels in the (d,p)-reaction. (auth)

38191 DECAY OF ^{44}K AND ^{44}Sc. Levkovskii, V. N.; Kazachevskii, I. V. (Inst. of Nuclear Physics, Alma-Ata, USSR). Yadern. Fiz.; 11: 483-4(Mar 1970). (In Russian).

The γ spectra of ^{44}K and ^{44}Sc were investigated by means of a Ge(Li) detector. The bound energy of the β spectrum of ^{44}K was measured with the scintillation β spectrometer. The ratio of β and γ radiations is established. Decay schemes for ^{44}K and ^{44}Sc are proposed. (auth)

38192 PHOTOPROTON CROSS SECTIONS FOR NUCLEI WITH (1f-2p) SHELL. Ishkhanov, B. S.; Kapitonov, I. M.; Piskarev, I. M.; Shevchenko, V. G.; Shevchenko, O. P. (Inst. of Nuclear Physics, Moscow). Yadern. Fiz.; 11: 485-91(Mar 1970). (In Russian).

Photoproton cross sections for the nuclei ^{52}Cr, ^{58}Ni and ^{60}Ni were measured for energies from the threshold up to 30 MeV. The protons with energies more than 1 MeV were registered. A number of maxima were found in the cross sections. The integral cross sections for ^{52}Cr, ^{58}Ni and ^{60}Ni are obtained to be 240, 570 and 320 MeV · mbarn, respectively. The anomalously high value of the photoproton production cross section for ^{58}Ni, as well as the shift of the centers of gravity for the photoproton cross sections toward higher excitation energies, as compared to the photoneutron cross section observed for ^{52}Cr and ^{60}Ni, may be explained by the influence of the analog states. (auth)

38193 ANGULAR DISTRIBUTIONS OF GAMMA RAYS FOLLOWING THE ^{64}Ni(p,nγ)^{64}Cu REACTION. Davidson, W. F.; Dallimore, P. J.; Hellstroem, J. (Australian National Univ., Canberra). Nucl. Phys.; A142: 167-76(1970).

Gamma-ray angular distributions in the reaction ^{64}Ni(p,nγ)^{64}Cu were measured under conditions where the incident proton energies were close to the neutron threshold for the levels of interest. Using the theoretical predictions of the compound nucleus statistical model, unique spin assignments were obtained for the 159 keV (2^+), 278 keV (2^+) and 609 keV (2^+) levels in ^{64}Cu, and the most probable spins for the other levels were found to be 344 keV (1^+), 362 keV (3^+), 663 keV (1^+), 739 keV (2^+ or 3^+), 745 keV (3^+), 878 keV (1^+ or 2^+), 895 keV (3^+) and 927 keV (1^+). Multipole mixing ratios of the γ-rays observed were also obtained. (auth)

38194 LIFETIME MEASUREMENTS FOR THE FIRST FIVE EXCITED STATES IN ^{33}S. Kavanagh, R. W.; Merdinger, J. C.; Schulz, N. (Centre de Recherches Nucleaires, Strasbourg). Nucl. Phys.; A146: 410-16(1970).

The lifetimes of the first five excited states of ^{33}S, populated with the ^{30}Si(α,n)^{33}S reaction, were investigated. From Doppler-shift attenuation measurements, mean lives of $1800 < \tau < 5400$, 90 ± 20, 145 ± 25, <15 and 36000 ± 8000 fs were found for the 842, 1968, 2313, 2869 and 2937 keV levels respectively. The results are compared with shell-model predictions. (auth)

38195 LIFETIME MEASUREMENTS IN sd-SHELL NUCLEI. III. MEAN LIVES OF ^{32}P LEVELS. van Middelkoop, G.; Gunsing, C. J. Th. (Robert J. Van de Graaff Laboratorium, Utrecht). Nucl. Phys.; A147: 225-34(1970).

The ^{29}Si(α,pγ)^{32}P reaction was used to study the γ-ray decay and the lifetimes of seven bound states of ^{32}P. A new level was found at E_x = 2216.5 ± 1.0 keV. Gamma rays were simultaneously measured in coincidence with protons detected at angles θ_p = 110° and –110° or 45° and –45°. From these Doppler-shift attenuation measurements the mean lives of the 0.51, 1.15, 1.32, 1.76, 2.18, 2.22 and 2.23 MeV levels were found to be 3000 ± 850, 270 ± 65, 380 ± 80, 510 ± 110, 60 ± 25, 210 ± 50 and 36 ± 20 fs, respectively. A previously reported level at E_x = 1.51 MeV was not observed. The data are compared with recent many-particle shell-model calculations. (auth)

38196 PRECOMPOUND PARTICLES IN ^{56}Fe(α,n)^{59}Ni REACTION. Rama Rao, J.; Rao, A. Lakshmana; Parthasaradhi, K. (Andhra Univ., Waltair, India). Nuovo Cim.; 68A: 203-6 (21 Jul 1970).

^{56}Fe(α,n)^{59}Ni reaction spectra at bombarding energies 14, 17, and 20 MeV are analyzed on the basis of theory of Griffin. Evidence for precompound particles is observed. An explanation for the variation of nuclear temperature with bombarding energy is presented. The temperatures are calculated leaving the energy spectrum contaminated by the precompound particles and independence of temperature with the bombarding energy is observed within the range of errors. (auth)

38197 LEVEL SCHEME OF ^{45}Sc. Biasi, P. (Univ., Florence. Istituto Nazionale di Fisica Nucleare, Florence); Fazzini, T. F.; Maurenzig, P. R.; Taccetti, N.; Ricci, R. A. Nuovo Cim.; 68A: 49-79(1 Jul 1970).

The ^{45}Sc level scheme was studied by the ^{45}Sc(p,p'γ) reaction at various bombarding energies between 1.8 and 4.5 MeV. Gamma and particle single and coincident spectra were observed, deducing branching ratios of various levels and indications on spin and parity. Some spins and parities were definitely fixed by means of electron conversion coefficient measurements and by Coulomb excitation with α particles. Namely levels at 543 ($^5/_2$), 938 ($^1/_2$), 974 ($^7/_2$), 1301 ($^3/_2$), 1433 ($^9/_2$), and probably 2031 ($^{11}/_2$) appear to have positive parity. The corresponding sequence is typical of rotational bands based upon the $1d_{\frac{5}{2}}$ and $2s_{\frac{1}{2}}$ proton-hole excitation. (auth)

38198 ANGULAR CORRELATION AND LIFETIME MEASUREMENTS FOR LOW-LYING ^{23}Na STATES. Maier, H. J.; Pronko, J. G.; Rolfs, C. (Univ., Freiburg i. B.). Nucl. Phys.; A146: 99-111(1970).

The lower excited states of ^{23}Na were studied using the method of γ–γ angular correlations for procuring spin and multipole mixing information and the attenuated Doppler-shift method for obtaining transition probabilities. The ^{23}Na(p,p') reaction was used at bombarding energies E_p = 4.12 and 5.15 MeV. The results of this investigation yield: E_x (keV), J, τ (psec) = 2077 ± 2, $^1/_2$, ≤0.3; 2389 ± 2, ≤$^1/_2$, $0.7^{+0.3}_{-0.2}$; 2639 ± 2, (not measured), $0.10^{+0.06}_{-0.04}$; 2703 ± 2, $^3/_2$, $0.10^{+0.06}_{-0.04}$; 2981 ± 2, ≥$^3/_2$, <0.1; 3681 ± 2, ≥$^3/_2$, <0.1. More restricted spin assignments can be made by combining these results with previously existing information. The results of this experiment are discussed in terms of the rotational model. (auth)

38199 LEVEL STRUCTURE OF ^{35}Cl FROM THE ^{32}S(α,pγ)^{35}Cl REACTION. Hooton, B. W.; Haeusser, O.; Ingebretsen, F.; Alexander, T. K. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. J. Phys.; 48: 1259-69(15 May 1970). (AECL–3570).

Proton-gamma coincidences from the reaction ^{32}S(α,pγ)^{35}Cl at E_α = 10.975, 11.960, and 12.120 MeV were measured, using method II of Litherland and Ferguson. Twelve previously unreported levels between 3.94 and 6.40 MeV excitation energy were found. The spins of four levels, 1.763 ($^5/_2$), 2.646 ($^1/_2$), 3.945 ($^9/_2$), and 4.885 ($^7/_2$), were determined. Possible spins were assigned to 12 of the other levels. Branching ratios and γ-ray multipole mixing ratios for all the levels studied are given. (auth) (Canada)

38200 MEASUREMENT OF THE MEAN LIVES OF THE FIRST EXCITED STATES OF ^{36}Ar NUCLEUS. Thibaud, J. P.; Aleonard, M. M.; Castera, D.; Hubert, Ph.; Leccia, F.; Mennrath, P. (Univ., Bordeaux). J. Phys. (Paris); 31: 131-4(Feb-Mar 1970). (In French).

Doppler-shift measurements of γ rays from the ^{35}Cl(p,γ)^{36}Ar reaction lead to the mean lifetimes τ_m = 400 ± 100, >2000, 125 ± 20, and 94 ± 30 fs for the levels ^{36}Ar* = 1970, 4178, 4413, and 4440 keV, respectively. The experimental electromagnetic transition rates are compared with the predictions of the vibrational model. (auth) (France)

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Refer also to abstracts 38101, 38104, 38146, 38154, 38162, 38170, 38174, 38186, 38188, and 38352.

38201 (CEA-N-1269) CATALOGUE OF β AND γ ACTIVITIES OF FISSION PRODUCTS. Barre, Bertrand; de Tourreil, Roland (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Apr 1970. 67p. Dep. CFSTI (U. S. Sales Only). (In French).

The whole of the data concerning the β and γ activities of fission products used for the codes PEPIN-LE-BREF and PICFEE are presented in this report in the form of 4 comprehensive tables: one for the nuclides, one for γ rays, one for energy balances and a fourth for the nuclide chains. (auth) (France)

38202 (CEA-N-1282) SIMULATION OF FISSION EXPERIMENTS BY THE MONTE-CARLO METHOD. Poitou, Jean; Nifenecker, Herve; Signarbieux, Claude (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Apr 1970. 48p. (In French). Dep. CFSTI (U. S. Sales Only).

A Monte-Carlo program which simulates the fission process with prompt neutron emission and the detection of these neutrons in a large liquid scintillator are presented. The interest of this program lies essentially in its ability to optimalize the scintillator geometry (different shapes have been investigated) to provide the best separation between the neutron components emitted from either of the fission fragments. This program also allows one to compute the detecting efficiency as a function of the initial velocity and the direction of the neutrons. (auth) (France)

38203 (COO-1505-41) TEST OF THE INDEPENDENCE HYPOTHESIS IN THE DECAY OF THE ^{210}Po COMPOUND NUCLEUS. Wong, P.; Daly, P. J.; Porile, N. T. (Purdue Univ., Lafayette, Ind. Dept. of Chemistry). 14 May 1970. Contract AT(11-1)-1505. 23p. Dep. CFSTI.

The angular distributions, cross sections, and recoil ranges of ^{207}Po from the ^{206}Pb(^{4}He,3n) and ^{207}Pb(^{3}He,3n) reactions were measured over the energy intervals 32 to 44 MeV and 21 to 33 MeV, respectively. The compound nuclear nature of these reactions was established by comparison of the average ranges with values expected for this mechanism. The angular distributions were used to derive values of the average total kinetic energy of the neutrons and photons emitted in these reactions. The partition of the excitation energy between these two decay modes was found to be equal for the two reactions to within at most 1.5 MeV. The expected difference in energy partition arising from angular momentum differences is approximately 0.5 MeV. (auth)

38204 (COO-1746-41) PRECISION MEASUREMENT OF THE ^{203}Hg BETA-GAMMA DIRECTIONAL CORRELATION. Cipolla, S. J.; Steffen, R. M. (Purdue Univ., Lafayette, Ind. Dept. of Physics). [1970]. Contract AT(11-1)-1746. 8p. Dep. CFSTI.

A precise measurement of the $\beta-\gamma$ directional correlation of ^{203}Hg as a function of the average β energy $\bar{W}$ (in units mc^2) is reported. The values of the anisotropy coefficient $A_{22}(\bar{W})$ in the $\beta-\gamma$ directional correlation function $W(\theta) = 1 + A_{22}(\bar{W})\, P_2(\cos\theta)$ are: $A_{22}(\bar{W} = 1.15) = -0.0007 \pm 0.0009$, $A_{22}(\bar{W} = 1.23) = -0.0016 \pm 0.0006$, $A_{22}(\bar{W} = 1.31) = -0.0020 \pm 0.0010$, $A_{22}(\bar{W} = 1.345) = -0.0018 \pm 0.0005$, and $A_{22}(\bar{W} = 1.38) = -0.0018 \pm 0.0011$. (auth)

38205 (EURFNR-777) NEW TOTAL NEUTRON CROSS SECTION MEASUREMENT OF URANIUM BETWEEN 0.5-4.35 MeV. Kopsch, D.; Cierjacks, S.; Kirouac, G. J. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Kernphysik). May 1970. 13p. (KFK-1199; CN-26/12). Dep. CFSTI (U. S. Sales Only).

Work Performed under United States-Euratom Fast Reactor Exchange Program.

The total neutron cross section of natural uranium was measured with the neutron time-of-flight facility at the Karlsruhe Isochronous Cyclotron (KIC). The measurement covers the energy range between 0.5 and 4.35 MeV with a resolution of 0.03 ns/m; this corresponds to an energy resolution between 290 eV at 0.5 MeV and 7.4 keV at 4.35 MeV. In the energy region 1.1 - 4.35 MeV the statistical error was between 1% and 0.5%, below 1.1 MeV the error increases up to 2.7% at 0.5 MeV. An extensive comparison with new available data is given. The existence of fluctuations in the cross section in the lower energy range is investigated. (auth)

38206 (INR-1149) THE INVESTIGATION OF THE PROBABILITIES OF ELECTROMAGNETIC TRANSITIONS IN NUCLEI WITH MASS NUMBER $125 \leq A \leq 153$. Kownacki, Jan (Institute of Nuclear Research, Warsaw (Poland)). 1970. 130p. (In Polish). Dep. CFSTI (U. S. Sales Only).

The half-life measurements of some excited states of ^{125,127}I, ^{125}Te, ^{147,149}Sm, and ^{151}Eu were performed. The delayed coincidence method was applied using a time-to-amplitude converter and long-lens magnetic beta-ray spectrometer adapted for the life time measurements. Based upon these measurements the reduced transition probabilities were established. The results were compared with the predictions of the single particle model as well as with the pairing-plus-quadrupole model used by L. S. Kisslinger and R. A. Sorensen for spherical nuclei. (auth)

38207 (INSJ-116) COLLECTIVE STATES OF ^{120}Sn EXCITED IN INELASTIC SCATTERING OF 14.698-MeV PROTONS. Koike, M.; Nonaka, I.; Taketani, H.; Nakamura, H.; Awaya, Y.; Wada, T. (Tokyo Univ. (Japan). Inst. for Nuclear Study). 31 Mar 1970. 12p. Dep. CFSTI (U. S. Sales Only).

The elastic scattering of 14.7-MeV protons by ^{120}Sn was studied. The observed angular distributions were analyzed using coupled-channel and DWBA calculations with the first-order collective interaction. Deformation parameters and reduced transition ratios were extracted for the excited levels. (J.W.R.)

38208 (JINR-E6-5070) LIFE-TIME MEASUREMENTS OF 2^+ ROTATIONAL STATES IN ^{182}Os AND ^{184}Os AND OF THE 1020 keV EXCITED STATE IN ^{204}Bi. Broda, R.; Golczewski, J.; Hrynkiewicz, A. Z.; Kulessa, R.; Walus, W. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1970. 15p. Dep. CFSTI (U. S. Sales Only).

The lifetimes of the 2^+ rotational states in ^{182}Os and ^{184}Os and of the 1020-keV excited state in ^{204}Bi were measured by means of the delayed coincidence method. The systematics of the measured lifetimes of the first 2^+ states in even osmium isotopes $^{182-192}$Os are presented. The experimental values of the lifetimes, intrinsic quadrupole moments Q_0 and the deformation parameters are compared to the theoretical calculations of Kumar and Baranger. (auth)

38209 (JINR-E15-5071) INVESTIGATION OF THE PROPERTIES OF THE SPONTANEOUSLY FISSIONING ISOMER ^{241}Pu IN THE REACTION (γ,n). Gangrskii, Yu. P., Markov, B. N.; Tsipenyuk, Yu. M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1970. 9p. Dep. CFSTI (U. S. Sales Only).

The reaction ^{242}Pu(γ,n) was studied in which a spontaneously fissioning isomer ^{241}Pu was formed with 23 ± 1 sec half-life. The ratio of the formation cross sections for isomeric and ground states of ^{241}Pu, $(9 \pm 2) \times 10^{-4}$, was measured along with the threshold of the reaction of isomeric state formation, (9.1 ± 0.15). From the comparison of the thresholds of the reaction leading to the ground and isomeric state the excitation energy of the spontaneously fissioning isomer ^{241}Pu, 2.9 ± 0.15 MeV, was determined. The data obtained are compared with the results on subbarrier resonances in the reaction ^{240}Pu(n,f). (auth)

38210 (JINR-P3-4992) PARAMETERS OF NEUTRON RESONANCES ^{233}U, ^{235}U, AND ^{239}Pu. Ryabov, Yu. V.; So Ton Sik; Chikov, N.; Yaneva, N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics). 1970. 36p. Dep. CFSTI (U. S. Sales Only).

The total cross sections of ^{233}U, ^{235}U, and ^{239}Pu and the fission and radiative capture cross sections of ^{235}U and ^{239}Pu were measured by the time-of-flight method with time resolution of 40 and 55 ns/m using the JINR pulsed fast reactor. The liquid boron scintillation detector was used to detect the resonance neutrons in the measurements of the total cross sections by the transmission method. The measurement of the total cross sections and that of fission and radiative capture by the self-indication method were carried out using a large cadmium-loaded liquid scintillation detector. The parameters $g\Gamma_n$, Γ, Γ_f, and Γ_c for 78 levels of ^{235}U and 32 levels of ^{239}Pu and the parameters $g\Gamma_n$, Γ for 13 levels of ^{233}U were calculated by the area method. (auth)

38211 (JINR-P3-5081) CALCULATIONS OF ENERGY SPECTRA OF FISSION FRAGMENTS AND VALUES $\bar{\nu}$ FOR TARGETS OF DIFFERENT THICKNESS. Dermendzhiev, E.; Panteleev, Ts. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics). 1970. 15p. (In Russian). Dep. CFSTI (U. S. Sales Only).

Energy spectra of fission fragments and $\bar{\nu}$ values are calculated for targets of different thickness. The results together with the data from the paper by S. Bochvarov et al. ["Physics and Chemistry of Fission" (IAEA, Vienna, 1969) p.465] give the value of the energy charge of fragments in ^{235}U resonances. It is shown that the account of the instrumental effect, connected with the fragment yield from relatively thick targets, does not eliminate the contradictions between the Dubna and USA data on $\bar{\nu}$ in ^{239}Pu resonances. (auth)

38212 (JUL-659-KP) NUCLEAR SPECTROSCOPIC INVESTIGATIONS OF THE DECAY ^{191}Hg $\rightarrow$ ^{191}Au. Beuscher, H., Jahn, P.; Lieder, R. M.; Mayer-Boericke, C. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Kernphysik). Apr 1970. 18p. (In German). (CONF-700321-1). Dep. CFSTI (U. S. Sales Only).

From German–Holland Meeting on Nuclear Physics, Eindhoven, Netherlands.

The decay $^{191}Hg \rightarrow {}^{191}Au$ was investigated. The mother isotope was produced in the Jülich isochronous cyclotron via the reaction $^{197}Au(d,8n)^{191}Hg$ with 80-MeV deuterons. The study of the decay was performed using Ge(Li) detectors and an orange-type beta-ray spectrometer. Energies and relative intensities of 16 new γ transitions were measured. For 9 transitions the multipolarities could be determined. A new isomeric state was observed in ^{191}Au with a half-life of 1.2 ± 0.3 s. (auth)

38213 (ORNL–4471) TABULATED CROSS SECTIONS FOR HYDROGEN AND HELIUM PARTICLES PRODUCED BY 62- AND 29-MeV PROTONS ON ^{120}Sn. Bertrand, F. E.; Peelle, R. W. (Oak Ridge National Lab., Tenn.). Jul 1970. Contract W-7405-eng-26. 60p. Dep. CFSTI.

Tabulated differential cross sections are presented for the production spectra of proton, deuteron, triton, helium-3, and alpha particles from ^{120}Sn bombarded by 62- and 29-MeV protons. Continuum cross sections in ~1-MeV bins are listed for 19 angles for 62-MeV incident protons, and for 5 angles for 29-MeV protons. The low-energy cutoffs range from 2 to 6 MeV for the different exit particle types. Angular distributions are given for excitation, by 62-MeV protons, of states at 0, 1.17, and 2.38 MeV in ^{120}Sn; and at 0, 0.73, 1.02, and 1.29 MeV in ^{119}Sn. Only the elastic scattering cross sections are given for incident 29-MeV protons, since there is an inadequate amount of data for angular distributions. (auth)

38214 (RLO–1388–113) EXCITATION ENERGY DEPENDENCE OF NEUTRON YIELDS AND FRAGMENT KINETIC ENERGY RELEASE IN THE PROTON INDUCED FISSION OF ^{233}U AND ^{238}U. Bishop, C. J.; Vandenbosch, R.; Aley, R.; Shaw, R. W. Jr.; Halpern, I. (Washington Univ., Seattle). [1968]. 25p. Dep. CFSTI.

The yields and energies of neutrons emitted from fission fragments of known mass were measured as a function of proton bombarding energy for ^{233}U and ^{238}U. The familiar sawtooth dependence of ν, the number of neutrons emitted per fragment, on the fragment mass was found to be considerably washed out with increasing bombarding energy, with the depth of the minimum at A ~ 132 decreasing more rapidly than that at A ~ 80. As the bombarding energy is increased the yield of neutrons from the heavy fragment increases more rapidly than does that of the light fragment. The results are interpreted in terms of qualitative considerations on energy-apportionment between fragments at the time of scission. Structure in the variation of the total fragment kinetic energy with mass ratio was observed to decrease at higher bombarding energies. The nuclear level density parameter $\underline{a}$ of the final fragments has been obtained as a function of fragment mass from the neutron kinetic energy and yield data. The $\underline{a}$ values are observed to increase for fragments near closed shells and to decrease for mid-shell fragments as the excitation energy is increased. (auth)

38215 (RLO–1388–120) GAMMA TRANSITIONS FROM HIGH SPIN STATES IN THE BETA-VIBRATIONAL BAND OF ^{154}Gd. Ferguson, S. M.; Heffner, R.; Ejiri, H. (Washington Univ., Seattle. Dept. of Physics). [1969]. 20p. Dep. CFSTI.

The rotational levels with spins up to 10^+ in the beta-vibrational band of ^{154}Gd were excited by the $^{154}Sm(\alpha,4n\gamma)^{154}Gd$ reaction. The intraband gamma transitions between the β-band levels and the interband gamma transitions from the β-band levels to the ground-band levels were measured with a Ge(Li) detector. The M1 components in the interband transitions between states with the same spin were deduced from the angular distributions. The ratios of E2 matrix elements of the interband to intraband transitions were obtained from the relative intensities of the observed lines. The general features of the transition-matrix elements were discussed in terms of a collective model with the rotation-vibration interaction. (auth)

38216 (RLO–2215–1) THE MEASUREMENT OF DELAYED NEUTRON ENERGY SPECTRA. Annual Progress Report. Woodruff, Gene L. (Washington Univ., Seattle. Dept. of Nuclear Engineering). Feb 1970. Contract AT(45-1)-2215. 10p. Dep. CFSTI.

The progress made in a project to measure delayed neutron spectra of thermally fissioning nuclei is reported. The preliminary work has included target preparation, development of a target irradiation system, and development of a data acquisition and storage system. (J.W.R.)

38217 (UCRL–72454) ^{235}U AND ^{239}Pu CAPTURE-TO-FISSION RATIO. Czirr, J. B.; Lindsey, J. S. (California Univ., Livermore. Lawrence Radiation Lab.). 4 May 1970. 14p. (CONF-700605–3). Dep. CFSTI.

From 2nd International Conference on Nuclear Data for Reactors, Helsinki, Finland.

A new experimental technique has been used to measure the neutron capture-to-fission cross-section ratio, α, for ^{235}U and ^{239}Pu. Data were obtained in the 0.1 eV to 30 keV energy range using neutron time-of-flight methods, with the Livermore 33-MeV linac providing a pulsed neutron source. The detector for both capture gammas and fission neutrons was a one-liter liquid scintillator viewed by a single 5-in photomultiplier tube. Fission neutrons were identified by pulse-shape-discrimination techniques applied to the signals from the deuterated-benzene scintillator. Capture and fission gamma events were pulse-height weighted on-line in order to obtain a signal which is independent of variations in the gamma spectra. The use of deuterated benzene as the scintillator solvent reduced the background arising from the capture of scattered neutrons. The fission-gamma contamination of the capture data was removed by a subtraction technique based on normalization at a resolved resonance with small capture-to-fission ratio. The resulting capture cross section was averaged over energy bins and divided by the averaged fission data after normalization to accepted α values near thermal neutron energy. The quantity $\langle\sigma_C\rangle/\langle\sigma_F\rangle$ is presented for both isotopes from 100 eV to 30 keV to provide the data necessary for detailed reactor calculations. For ^{235}Pu, $\langle\sigma_C\rangle/\langle\sigma_F\rangle = 0.80 \pm 0.05$ when averaged from 0.10 to 10 keV. (The quoted error includes estimated systematic uncertainties.) The present results indicate a considerably larger loss to ^{240}Pu production than previously assumed, for some fast breeder reactor designs. (auth)

38218 (UCRL–72472) keV FISSION CROSS SECTION OF ^{235}U MEASURED WITH HIGH RESOLUTION. Bowman, C. D.; Stelts, M. L.; Baglan, R. J. (California Univ., Livermore. Lawrence Radiation Lab.). 13 May 1970. 21p. (CONF-700605–2). Dep. CFSTI.

From 2nd International Conference on Nuclear Data or Reactors, Helsinki, Finland.

The fission cross section of ^{235}U was measured with a resolution of 1 nsec/meter from 1.5 to 500 keV. Structure in the cross section was detected at neutron energies as high as 200 keV. It is shown that, while the structure has had no appreciable effect on the accuracy of other keV measurements carried out with nearly monoenergetic sources of neutrons, care will be necessary in future attempts to satisfy requests for cross section accuracy of a few percent or less. The resolution of the experiment probably is sufficient to reveal much more structure than was actually observed. The structure which is observed, therefore, might be interpreted as intermediate structure in the average cross section. (auth)

38219 (UCRL-Trans–10467) DECAY OF ^{170}Lu TO ^{170}Yb. Bonch-Osmolovskaya, N.; Ballund, H.; Zglinski, A.; Plochocki, A.; Preibisz, Z. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). Translated by B. Thayne for Univ. of California, Lawrence Radiation Lab., Livermore, from report JINR–P6–4773). 45p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 24: 22141.

38220 (WAPD-TM–837) INTEGRAL MEASUREMENTS OF THE ^{233}Pa NEUTRON CAPTURE CROSS SECTION (LWBR DEVELOPMENT PROGRAM). Connor, J. C. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Jun 1970. Contract AT-11-1-GEN-14. 30p. Dep. CFSTI.

The thermal neutron capture cross section and resonance integral of ^{233}Pa were measured by irradiating bare and cadmium-covered thorium wires, and, after suitable chemical separations, determining the amounts of ^{233}U and ^{234}U produced. Earlier results reported for the resonance integral are reviewed and additional data are included. The cadmium-covered thorium data now provide an average ^{233}Pa resonance integral result of 857 ± 35 barns, which is 15 barns higher than the value reported previously. This result includes the 1/v component of the cross section and is appropriate for a 1/E spectrum and a perfect filter with a low energy cutoff of 0.5 eV. The bare thorium wire data provide an average 2200 m/sec ^{233}Pa cross section result of 38.3 b. (auth)

38221 INVESTIGATION OF THE ALPHA SPECTRUM OF SHORT-LIVED RARE EARTH ISOTOPES. Mahunka, I. (Inst. of Nuclear Research, Debrecen, Hungary). Acta Phys. Acad. Sci. Hung.; 28: 229–35(1970). (In Russian).

The alpha-particle energies, half-lives and alpha branching ratios of ^{150}Dy, $^{151,152,153}Ho$, $^{153,154,155}Er$ were investigated with a semiconductor alpha-spectrometer. The isotopes were produced by spallation of Ta, Lu, Er and Dy with 660-MeV protons. (auth)

38222 INTERNAL CONVERSION RATIOS FOR THE HIGHER SHELLS AT THE 364-keV TRANSITION IN THE DECAY OF ^{131}I. Juhasz, S. (Kossuth Lajos Univ., Debrecen, Hungary); Ujhelyi,

Cs.; Berenyi, D.; Illes, F. Acta Phys. Acad. Sci. Hung.; 28: 13-16(1970).

The $L_I/L_{II}/L_{III}$, M/L and (N + O)/M conversion ratios of the 364-keV transition in the decay of ^{131}I were determined by using a special permanent magnet beta-ray spectrograph with a maximum radius of 75 cm. The 1 : 0.24 : 0.16 ratios received for $L_I/L_{II}/L_{III}$ are in good agreement with the only earlier datum of Wolfson et al. The M/L = 0.195 ± 0.0027 is compared with the theoretical values. For the (N + O)/M ratio there is no calculated value but the experimental value 0.25 ± 0.04 very well agrees with Mladjenovic's mean value for (N + O)/M ratio obtained by averaging the data for several E2 transitions in a wide region of Z. (auth)

38223 INVESTIGATION OF THE ALPHA SPECTRUM OF Po ISOTOPES. Raichev, H.; Tron, L. Acta Phys. Acad. Sci. Hung.; 28: 263-8(1970). (In Russian).

The alpha-radiation of Po isotopes produced by the reaction Bi(p,xn)Po was studied with a semiconductor spectrometer. Alpha energies and half-lives were determined for ^{200}Po, ^{201}Po, ^{201m}Po ^{202}Po, ^{204}Po, ^{206}Po, and ^{208}Po. (auth)

38224 SHELL-MODEL CALCULATIONS ON THE N = 82 ODD-PROTON NUCLEI. I. Waroquier, M.; Heyde, K. (Univ., Ghent). Nucl. Phys.; A144: 481-501(1970).

Shell-model calculations for the single-closed shell nuclei with N = 82 neutrons are performed by the use of a surface-delta interaction (SDI) as residual nucleon-nucleon interaction. The resemblance with more realistic two-body forces is discussed. The single-particle energies are determined by solving the inverse-gap equations (IGE). The shell-model Hamiltonian is diagonalized in a one- and three-quasiparticle space after elimination of spurious states. Various approximation methods as second-order perturbation calculations and a phonon treatment are studied. The calculated spectroscopic factors are studied and compared with the experimental one-nucleon transfer data with good quantitative agreement. (auth)

38225 STRONGLY PERTURBED POSITIVE-PARITY BANDS IN ODD-MASS ERBIUM ISOTOPES. Hjorth, S. A. (Univ. of Stockholm); Ryde, H.; Hagemann, K. A.; Loevhoeiden, G.; Waddington, J. C. Nucl. Phys.; A144: 513-38(1970).

Alpha-particle irradiation of enriched dysprosium targets was used to populate states in ^{161}Er, ^{163}Er and ^{165}Er. Cascade and crossover transitions are observed within a strongly perturbed rotational band which is populated up to $^{25}/_{2}$. The observed band structure can be understood to be the lowest-energy band which results from strong coupling through the Coriolis force of the Nilsson orbitals $^{1}/_{2}^{+}[660]$, $^{3}/_{2}^{+}[651]$, $^{5}/_{2}^{+}[642]$, $^{7}/_{2}^{+}[633]$ and $^{9}/_{2}^{+}[624]$. The wave functions were calculated from a fit to the experimental energies and the theoretical and experimental transition probabilities are compared. Rotational bands built on the intrinsic states $^{3}/_{2}^{-}[521]$, $^{5}/_{2}^{-}[523]$ and $^{11}/_{2}^{-}[505]$ were also observed. (auth)

38226 PENETRATION EFFECTS ON INTERNAL CONVERSION FOR 1-FORBIDDEN M1 TRANSITIONS IN A UNIFIED MODEL. Vanden Berghe, G.; Heyde, K. (Univ., Ghent). Nucl. Phys.; A144: 558-76(1970).

Penetration factors λ are calculated for 1-forbidden M1 transitions for the nuclei $^{119,121,125}Sb$, $^{129,131}I$, ^{143}Pr and $^{147,149}Pm$. The penetration matrix elements M_λ are calculated in a unified model, according to the general formulae of Church and Weneser. Gamma transition matrix elements M_γ are calculated from experimental half-lives and total conversion coefficients. Where experimental K-conversion coefficients and L-subshell ratios are available, experimental penetration factors λ are determined from these data. The L-subshell ratios are re-analyzed with the use of the penetration effects. (auth)

38227 INVESTIGATION OF THE ALPHA SPECTRUM OF THE PRODUCTS OF THE REACTION $^{175}Lu + {}^{20}Ne \rightarrow {}^{195*}Tl$. Mahunka, I.; Tron, L.; Fenyes, T. (Inst. of Nuclear Research, Debrecen, Hungary). Acta Phys. Acad. Sci. Hung.; 28: 237-44 (1970). (In Russian).

Products of the reaction $^{170}Lu + {}^{20}Ne$ were collected by the helium sweeping technique, and their α-radiation analyzed with a semiconductor spectrometer. The α-particle energies E_α, the half-lives $T_{\frac{1}{2}}$, and the excitation functions of the reactions in the energy interval of 135 to 177 MeV were measured. The observed α-groups were tentatively identified as belonging to ^{183}Au, ^{185}Hg, and ^{187}Hg. (auth)

38228 FRAGMENT ANGULAR DISTRIBUTIONS FROM NEUTRON-INDUCED FISSION OF ^{242}Pu. Otozai, K. (Argonne National Lab., Ill.); Meadows, J. W.; Behkami, A. N.; Huizenga, J. R. Nucl. Phys.; A144: 502-12(1970).

Fission fragment angular distributions were measured for the fission of ^{242}Pu induced by monoenergetic neutrons of energies 500, 620, 730, 990, and 1230 keV. The fission fragments were detected by two independent methods, polycarbonate resin detectors and surface barrier solid-state detectors. The experimental data were analyzed in terms of both a single-particle and statistical model of the intermediate transition nucleus. (auth)

38229 MEASUREMENT OF THE CAPTURE-TO-FISSION RATIO FOR ^{239}Pu. Czirr, J. B.; Lindsey, J. S. (Univ. of California, Livermore). Nucl. Sci. Eng.; 41: 56-62(Jul 1970).

The ratio of the neutron capture-to-fission cross section (α) has been measured for ^{239}Pu in the energy range from 100 eV to 30 keV. Neutron time-of-flight techniques were used to obtain data with an energy resolution of approximately 10% at 10 keV. The data yield an average $\alpha = 0.80 \pm 0.05$ between 0.10 and 10 keV for an energy-independent incident neutron spectrum. Also, α data were obtained in the resolved resonance region below 100 eV. (auth)

38230 THE SPINS OF LOW-ENERGY NEUTRON RESONANCES OF ^{155}Gd AND ^{157}Gd. Asghar, M.; Ribon, P.; Silver, E.; Trochon, J. (CEN, Saclay, France). Nucl. Phys.; A145: 549-60(1970).

The resonant scattering method in combination with the available transmission data and the gamma-ray cascade technique have been used to determine the spin values of compound nuclei ^{156}Gd and ^{158}Gd resonances. While scattering measurements were made on both enriched isotopes of ^{157}Gd and natural Gd, only natural Gd was available for the γ-ray cascade experiment. Altogether 29 and 24 spin assignments have been made for ^{155}Gd and ^{157}Gd respectively. The distribution of spins is consistent with the (2J + 1) law. The values of s-wave strength function for each spin state are for ^{155}Gd, $(S_0)_{J=1} = (1.38) \pm 0.73) \times 10^{-4}$, $(S_0)_{J=2} = (1.72 \pm 0.60) \times 10^{-4}$, and for ^{157}Gd, $(S_0)_{J=1} = (2.94 \pm 1.56) 10^{-4}$ and $(S_0)_{J=2} = (2.26 \pm 0.88) \times 10^{-4}$. Within the statistical errors, these values show no spin dependence of the s-wave strength function. (auth)

38231 EXCITATION FUNCTION FOR THE $^{109}Ag(d,2n)^{109}Cd$ REACTION. Roehm, H. F.; Steyn, J.; Rautenbach, W. L.; Verwey, C. J. (National Physical Research Lab., Pretoria). J. Inorg. Nucl. Chem.; 32: 1413-17(May 1970).

The excitation function for the $^{109}Ag(d,2n)^{109}Cd$ reaction was determined from 0 to 16 MeV by the "stacked foil" technique. The maximum measured cross section for the production of ^{109}Cd from natural silver was 930 ± 23 mbarn at 13.3 MeV. The thick-target yield was calculated as a function of energy; the calculated production rate of ^{109}Cd by 16-MeV deuterons on natural silver was 5.93 μCi/μA-hr. This was subsequently also measured as $5.66^{+0.20}_{-0.10}$ μCi μA-hr. (auth) (UK)

38232 NUCLEAR CHARGE RADII FROM ATOMIC K X RAYS. Bhattacherjee, S. K.; Boehm, F.; Lee, P. L. (California Inst. of Tech., Pasadena). Contract AT(04-3)-63. Phys. Rev.; 188: 1919-29(20 Dec 1969).

Isotope shifts of K x-ray transitions were measured in several isotopes of Gd, Dy, Er, and Hf. The results of these observations, together with results of previously communicated measurements on Sn, Nd, Sm, W, Hg, Pb, and U, were analyzed in terms of even nuclear charge moments. The dominant moment $\delta\langle r^2\rangle$ is listed for 26 isotope pairs. A comparison of the x-ray shifts with the optical isotope shifts furnishes in several cases the optical specific mass shifts. The difficulties of comparison with muonic x-ray isotope shifts are discussed. (auth)

38233 FISSION CROSS SECTIONS AND THE FISSION FRAGMENT DISTRIBUTION FROM BOMBARDMENT OF LIGHT NUCLEI BY ^{20}Ne IONS. Obukhov, A. I.; Perfilov, N. A.; Shigaev, O. E.; Tkachenko, E. G. Yadern. Fiz.; 11: 977-81(May 1970). (In Russian).

Fission of nuclei produced from bombardment of Sn and Ag targets by ^{20}Ne ions with energies 198, 183, and 168 MeV was studied. Solid-state track detectors were used to record the fission fragments. The fission cross sections and the fragment angular distributions are obtained. It is found that the fission cross sections for the light nuclei produced at bombardment of Sn and Ag targets by the ^{20}Ne ions with energy about 200 MeV are considerably more (by 2 to 3 orders of magnitudes) than the fission cross sections for the same nuclei at bombardment by protons. The difference in magnitude of the nuclear fissionability for the two cases is ascribed to the effect of a large angular momentum arising in the nucleus from the heavy ion. (auth)

38234 MEASUREMENT OF LIFE TIMES OF ^{181}Gd EXCITED STATES. Morozov, V. A.; Muminov, T. M.; Razov, V. I. (Joint Inst. of Nuclear Research, Dubna, USSR). Yadern. Fiz.; 11: 921-4(May 1970). (In Russian).

Lifetimes are determined for the ^{151}Gd excited states at 108.1, 395.2, 575.3, and 839.3 keV with spins $\frac{5}{2}^-$, $\frac{3}{2}^-$, $\frac{1}{2}^-$, $\frac{3}{2}^-$, respectively. It is shown that the states at 108.1 and 395.2 keV are of the phonon type. (auth)

38235 INVESTIGATION OF α DECAY OF ISOTOPES ^{228}Th AND ^{229}Th. Baranov, S. A.; Shatinskii, V. M.; Kulakov, V. M.; Rodionov, Yu. F. (Inst. of Atomic Energy, Moscow). Yadern. Fiz.; 11: 925-33(May 1970). (In Russian).

Results of a study of α decays of the isotopes ^{228}Th and ^{229}Th are presented. The major experiments are fulfilled with a $\pi\sqrt{2}$ space focussing magnetic α spectrograph. In the case of ^{228}Th, α groups are found corresponding to the transitions into the ^{224}Ra levels with quantum numbers 0^+, 2^+, 4^+ (ground state band) and 1^-, 3^- (octupole oscillation band). It is established that the momentum of inertia in case of the ^{224}Ra octupole state is by 80% larger than in case of the ground state. In the ^{229}Th spectrum more than thirty α lines are detected, the major part of which for the first time. Evidence is obtained that a rotation band with quantum numbers $\frac{1}{2}^+$[633] exists in the daughter nucleus. (auth)

38236 EXCITATION FUNCTIONS ON REACTIONS (p,n) ON SOME Sn ISOTOPES AND ISOMERIC RATIOS. Klyucharev, A. P.; Skakun, E. A.; Rakivnenko, Yu. N.; Romanii, I. A. (Physical-Technical Inst., Kharkov). Yadern. Fiz.; 11: 953-7(May 1970). (In Russian).

Excitation functions of the reactions (p,n) are measured on $^{116-120,122}$Sn nuclei using the activation method in the region of incident protons up to 8.5 MeV. For ^{118,120,122}Sn and ^{197}Au, ratios of isomeric pair production cross sections are measured. Theoretical analysis made for reactions ^{118}Sn(p,n)^{118m}Sb and ^{120}Sn(p,n)^{120m,g}Sb by the Vandenbosch–Huizengi method gives the values of the spin cut-off parameter, which was found to be 3.5 ± 1 and 4.0 ± 1, respectively. (auth)

38237 MEASUREMENT OF THE STATIC QUADRUPOLE MOMENTS OF THE FIRST 2^+ STATES OF ^{194}Pt, ^{196}Pt, AND ^{198}Pt. Glenn, J. E.; Pryor, R. J.; Saladin, J. X. (Univ. of Pittsburgh). Phys. Rev.; 188: 1905-9(20 Dec 1969).

The values of the B(E2, $0^+ \rightarrow 2^+$) and the static quadrupole moments of the first 2^+ states of ^{194}Pt, ^{196}Pt, and ^{198}Pt are determined. The evaluation includes a discussion of quantum-mechanical effects as well as the influence of atomic screening. (auth)

38238 ANGULAR CORRELATION MEASUREMENTS IN ^{185}Re. Badica, T.; Gelberg, A.; Salageanu, S. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys.; 14: 1099-1104(1969).

The spin values of several excited states in ^{185}Re following electron capture in ^{185}Os were determined by γ – γ angular correlations. The level scheme of ^{185}Re is discussed. (auth)

38239 DEFORMED STATES OF ODD SILVER NUCLEI. Begzhanov, R. B.; Kobilov, O. Sh.; Radzhabov, P. S.; Sabirov, Kh. S. (Inst. of Nuclear Physics, Tashkent). Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk; No. 4, 47-52(1969). (In Russian).

In view of the contradictory data in the literature of the lifetimes, spins, and parities of levels in ^{107}Ag and ^{109}Ag, the excited states of these odd silver nuclei were investigated. A fast-slow coincidence system with a time resolution of 0.6 to 2.0 nsec was used to measure the lifetimes of the excited states. The levels of ^{107}Ag were studied during the decay of ^{107}Cd, obtained by the proton irradiation of natural silver; the Pd isotope used for the experiments with ^{109}Ag was prepared by the exposure of enriched Pd to thermal neutrons. The half-life of the 922-keV level of ^{107}Ag was found to be $T_{\frac{1}{2}} < 0.6 \times 10^{-9}$ sec; that of the 724- and 870-keV levels of ^{109}Ag were $T_{\frac{1}{2}} < 0.5 \times 10^{-9}$ sec. The angular correlations of the 413-311 keV and 898-325 keV cascades were determined for the first time; other values agreed with earlier data in the literature. The results were not sufficient to interpret the highly excited states of the two nuclei on the basis of the Nilsson model. These states are probably collective ones because their E2 transitions are accelerated and the predominant decay passes through the $\frac{9}{2}^-$ and $\frac{7}{2}^-$ states. The spin of the 1143-keV level was found to be $\frac{9}{2}$ with a negative parity and not $\frac{7}{2}^-$, as reported before. (TTT)

38240 DECAY SCHEME ^{117}Cd AND ^{117m}Cd. El-Bedewi, F. A.; Miligy, Z.; Eissa, N. A.; Mohsen, M. (Ain Shams Univ., Cairo). Acta Phys. Acad. Sci. Hung.; 28: 41-51(1970).

The gamma rays of ^{117}In following the beta decay of ^{117}Cd and ^{117m}Cd were studied with a scintillation coincidence spectrometer. Twenty-one gamma transitions were observed with energies ranging from 2260 keV to 270 keV. Two of these transitions with energies of 1680 and 480 are considered to be new. The level scheme of ^{117}In as well as the decay scheme of ^{117}Cd and ^{117m}Cd are proposed. (auth)

38241 ABNORMAL ANGULAR DISTRIBUTION OF FRAGMENTS FROM FISSION ON Ra NUCLEI BY NEUTRONS WITH ENERGY 14 TO 16 MeV. Babenko, Yu. A.; Nemilov, Yu. A.; Pleskachevskii, L. A.; Selitskii, Yu. A.; Funshtein, V. B. Yadern. Fiz.; 11: 1006-11(May 1970). (In Russian).

Fragment angular distributions for fission of ^{226}Ra by neutrons with energies 12.6 to 19.5 MeV are measured. Abnormal shape of the distribution, that is, enhanced fragment yield at the angle of ~60° at E_n = 14.6 to 15.6 MeV, is explained as due to the channel structure of the fission barrier of the ^{225}Ra nuclei produced from ^{227}Ra after evaporating two neutrons. The fission barrier of ^{225}Ra is found to be 7.0 ± 0.5 MeV. The total cross section varies slightly from 21 to 33 mb in the energy interval E_n = 15.6 to 19 MeV. (auth)

38242 NEUTRONS AND γ-QUANTA FROM TRIPLE FISSION OF ^{252}Cf. Adamov, V. M.; Drapchinskii, L. V.; Kovalenko, S. S.; Petrzhak, K. A.; Tyutyugin, I. I. Yadern. Fiz.; 11: 1001-5(May 1970). (In Russian).

Numbers of prompt neutrons and γ-quanta are measured, for spontaneous fission of ^{252}Cf with emission of long-range α-particles, in relation to their number for binary fission. The neutron number for triple fission is found to be 2.83 ± 0.07. The numbers and spectra of the γ-quanta are equal in both binary and triple fission processes. Dependence of the mean neutron and γ-quanta numbers on the α-particle energy is measured. It is established that the neutron and γ-quanta numbers with energies above 2 MeV decrease with rise of the α-particle energy. The neutron number falls by 0.33 as the α-particle energy increases from 15 up to 25 MeV. With these data one is able to estimate the fragment excitation energy at the moment of the α-particle emission. The result is about 7 MeV. (auth)

38243 FAST-NEUTRON TOTAL AND SCATTERING CROSS SECTIONS OF BISMUTH. Smith, A. B. (Argonne National Lab., Ill.); Whalen, J. F.; Barnard, E.; de Villiers, J. A. M.; Reitmann, D. Nucl. Sci. Eng.; 41: 63-9(Jul 1970).

Total neutron cross sections of bismuth were measured with resolutions of <3 keV over the energy range 0.2 to 1.4 MeV. Differential elastic-scattering cross sections were determined at intervals <50 keV from 0.3 to 1.5 MeV with resolutions of ~20 keV. The inelastic-neutron excitation of a state at 896 ± 1 keV was observed and the respective differential excitation cross sections determined with incident resolutions of ≥12 keV. Partially resolved resonance structure was evident in all the measured values. The experimental results were assayed for possible intermediate structure and were compared with the results of optical model and statistical calculations. The model calculations were inclusive of contributions due to the fluctuation and correlation of compound-nucleus resonance widths and of the shell closure at N = 126. (auth)

38244 ANGULAR ANISOTROPY OF ^{239}Pu PHOTOFISSION. Soldatov, A. S.; Tsipenyuk, Yu. M.; Smirenkin, G. N. (Physico-Energetics Inst., Moscow). Yadern. Fiz.; 11: 992-1000(May 1970). (In Russian).

Energy dependence of cross section and angular anisotropy of ^{239}Pu photofission near threshold is studied at the microtron of the Institute of Physical Problems. Experimental data on the reactions ^{239}Pu(γ,f) and ^{239}Pu(n,f) are simultaneously analyzed. The quasistationary state of ^{239}Pu fissible nucleus at the excitation energy 5.6 MeV is found to be 0.5 MeV below the barrier. (auth)

38245 DETERMINATION OF THE QUADRUPOLE MOMENTS OF FIRST EXCITED 2^+ STATES IN ^{114}Cd AND ^{56}Fe BY COULOMB EXCITATION. Schilling, G.; Scharenberg, R. P.; Tippie, J. W. (Purdue Univ., Lafayette, Ind.). Contract AT(11-1)-1746. Phys. Rev., C; 1: 1400-8(Apr 1970).

The differential Coulomb-excitation probability for the 0.558-MeV 2^+ excited state in ^{114}Cd and for the 0.847-MeV 2^+ excited state in ^{56}Fe are measured by Coulomb exciting with ^{16}O ions of 25- and 30-MeV incident energy. Inelastically scattered ions are separated from ions scattered elastically by requiring a coincidence with a deexcitation γ ray detected in a large scintillator placed close to the target. The differential excitation probability is interpreted in terms of the reorientation effect to yield the static electric quadrupole moments for the 0.558-MeV 2^+ state in ^{114}Cd, $Q_{2^+} = -0.64 \pm 0.19 \times 10^{-24}$ cm^2, and for the 0.847-MeV 2^+ state in ^{56}Fe, $Q_{2^+} = -0.345 \pm 0.054 \times 10^{-24}$ cm^2. (auth)

38246 ISOBARIC ANALOG RESONANCES IN PROTON ELASTIC SCATTERING FROM ^{110}Cd, ^{112}Cd, AND ^{114}Cd. Mistry, V. D.; Hollas, C. L.; Hiddleston, H. R.; Riley, P. J. (Univ. of Texas, Austin). Phys. Rev., C; 1: 1595-1607(Apr 1970).

Excitation functions are measured for elastic and inelastic scattering of protons from ^{110}Cd, ^{112}Cd, and ^{114}Cd at proton energies from 6.0 to 11.0 MeV. The isobaric-analog resonances observed in ^{111}In, ^{113}In, and ^{115}In nuclei are analyzed by fitting the elastic excitation functions using a shell-model approach to reac-

tion theory to extract quantitative nuclear-structure information for the parent analog states in ^{111}Cd, ^{113}Cd, and ^{115}Cd. Spectroscopic factors are evaluated, and their dependence on the choice of optical and bound-state potentials is studied. Coulomb displacement energies are also obtained from these data. Comparisons are made with existing (d,p) work on ^{110}Cd, ^{112}Cd, and ^{114}Cd. In general, there is reasonable agreement between the (p,p$_0$) and (d,p) spectroscopic factors, excitation energies, orbital angular momenta, and total angular momenta. (auth)

38247 ^{208}Pb(d,α)^{206}Tl REACTION AND THE $\pi^{-1}\nu^{-1}$ STRUCTURE OF ^{208}Tl. Lewis, M. B.; Daehnick, W. W. (Univ. of Pittsburgh). Phys. Rev., C; 1: 1577-94(Apr 1970).

The proton-neutron hole states of ^{208}Tl are studied by the direct ^{208}Pb(d,α)^{206}Tl reaction with 17-MeV deuterons. Experimental resolutions of 12 to 15 keV for about 28-MeV α particles permit the investigation of many two-hole states previously unknown. For most levels, L values can be extracted from the comparison of microscopic two-nucleon transfer distorted-wave Born-approximation (DWBA) calculations with experimental angular distributions. The experimental level energies and J^π assignments (or limits) are compared where possible to recent (n,γ) and (t,α) data for ^{206}Tl, and to structure calculations by Kuo. It is possible to correlate about 20 low-lying levels ($E_x \lesssim 2.2$ MeV) with calculated shell-model states. In addition, Kuo's wave functions are used to derive detailed (d,α) cross-section intensity distributions, and to check the dependence of the absolute normalization constant N(d,α) on various DWBA parameters. Constructive coherence in the transition amplitudes predicted by the wave functions for the lowest states of a given J^π is verified experimentally. Ten enhanced (d,α) cross sections are observed, in good qualitative agreement with theoretical predictions. The predicted enhancement for the population of some of these states is occasionally in excess of the observed enhancement. (auth)

38248 DETERMINATION OF THE ELECTRIC QUADRUPOLE MOMENT OF THE FIRST 2^+ STATES OF ^{188,190,192}Os. Pryor, R. J. (Univ. of Pittsburgh); Saladin, J. X. Phys. Rev., C; 1: 1573-7(Apr 1970).

The spectroscopic quadrupole moments of the first 2^+ states of ^{188,190,192}Os are determined by means of Coulomb-excitation experiments. The results are compared with recent-model calculations and found to be in rather good agreement with these predictions. (auth)

38249 STUDY OF Dy(^{40}Ar,xn)Po REACTIONS. Sikkeland, T.; Silva, R. J.; Ghiorso, A.; Nurmia, M. J. (Univ. of California, Berkeley). Phys. Rev., C; 1: 1564-72(Apr 1970).

Cross sections are measured for the production of Po nuclides with mass numbers 194 to 200 in bombardments of a 92.7% ^{164}Dy target with ^{40}Ar ions in the ion-energy range 160 to 280 MeV. The maximum cross sections are 0.5, 2.1, 8.0, 35, 50, 70, and 20 mb for the production of mass numbers 194, 195, 197, 198, 199, and 200, respectively. Isomer ratios for the odd-A nuclides are obtained. A good fit is obtained between the shapes of calculated and experimental excitation-function curves. The fit involves (a) calculation of the compound-nucleus cross section by the use of the parabolic approximation to the real part of the optical-model potential with the parameters $V_0 = -70$ MeV, $r_0 = 1.26$ F, and d = 0.44 F; (b) modification of Jackson's formula for the probability for neutron emission to include angular-momentum effects using T = 1.2 MeV and $\mathfrak{F}/\mathfrak{F}^0 = 1.4$; and (c) assumption of an energy independence for the average partial level width for neutron emission. In the fitting process, experimental values for the latter quantity are obtained to which an empirical formula is fitted. Fission is the main competing mode of decay. (auth)

38250 METHOD FOR DETERMINING SPINS OF NEUTRON RESONANCES. Wetzel, K. J.; Thomas, G. E. (Argonne National Lab., Ill.). Phys. Rev., C; 1: 1501-7(Apr 1970).

The proposed method for measuring the spin of S-wave neutron resonances is based on the detailed properties of the low-energy capture γ-ray spectrum. Measurements on nuclei with resonance of known spin show that this method gives reliable spin assignments. It is also applied to unassigned resonances in ^{167}Er and ^{187,189}Os. (auth)

38251 MEAN LIFE OF THE 343-keV STATE IN ^{111}Cd. Rama Murty, V. V.; Rama Rao, M. T.; Lakshminarayana, V. (Andhra Univ., Waltair, India). Phys. Rev., C; 1: 1498-1501 (Apr 1970).

The mean life of the 343-keV state in ^{111}Cd is measured, using the delayed coincidence method, employing a β-γ coincidence arrangement, with plastic crystals and the centroid shift technique. A value of 85 ± 17 psec is obtained for the mean life. This is in complete disagreement with the previous Coulomb-excitation results, and is in agreement with that of the resonance scattering experiment. The transition probabilities T(E2) and T(M1) are estimated, using the present value of the mean life and the available values of the conversion coefficient, mixing and branching ratios. An E2 enhancement of 7.5 ± 2 and M1 hindrance of 129 ± 33 over the single-particle estimates are noted. The theoretical values estimated using the wave functions of Kisslinger and Sorensen as well as those of Barnes are found to be unsuitable for the estimation of the transition probabilities. The experimental values are therefore employed to obtain phenomenological wave functions for the ground and the 343-keV states. The resultant wave functions show dominant $d_{\frac{1}{2}}$ plus phonon contributions in both the ground and the 343-keV state. (auth)

38252 ANALYSIS OF THE ^{208}Pb(d,p)^{209}Pb g.s. REACTION. King, K.; McKellar, Bruce H. J. (Univ. of Sydney). Phys. Rev., C; 1: 1538-47(Apr 1970).

The ^{208}Pb(d,p)^{209}Pb ground-state reaction is analyzed using the method of Butler, Hewitt, McKellar, and May. Using proton parameters fitted to elastic scattering data and Rosen's neutron parameters, good agreement with the proton angular distribution is obtained when the energy of the incident deuteron is above the Coulomb barrier. The spectroscopic factor extracted from the data is 0.65 ± 0.1. (auth)

38253 DECAY OF ^{186}Ta TO LEVELS IN ^{186}W. Pathak, B. P. (Saha Inst. of Nuclear Physics, Calcutta); Murty, K. S. N.; Mukherjee, S. K.; Gujrathi, S. C. Phys. Rev., C; 1: 1477-90(Apr 1970).

The β decay of ^{186}Ta to the levels in ^{186}W is studied using scintillation and Ge(Li) spectrometers. The sources of ^{186}Ta are obtained by the ^{186}W(n,p)^{186}Ta reaction on enriched as well as on natural samples of tungsten with a 14.8-MeV neutrons. The half-life of ^{186}Ta is measured as 10.5 ± 0.5 min. γ rays which are assigned to the decay of ^{186}Ta are 94, 122.5, 183.5, 198, 214, 274.2, 291, 295, 308, 314, 322, 341.5, 411, 418, 424, 440, 458, 462, 510, 536, 567, 583.5, 605, 615.5, 637, 656, 708, 726, 736.5, 738, 753.3, 755, 758, 785, 799, 829.5, 846, 870, 884, 891.5, 921, 925, 952, 1014, 1027.5, 1080, 1111, 1124.5, 1151.5, 1173, 1211.5, 1247, 1274, 1438, and 1486 keV. The study of the β spectrum, using an anthracene scintillation spectrometer, shows the existence of four β groups with the end-point energies of 3.10 ± 0.15 (5%), 2.50 ± 0.10 (32%), 2.20 ± 0.10 (49%), and 1.5 ± 0.2 (14%) MeV. The β-γ and γ-γ coincidence studies are made, and a level scheme of ^{186}W is proposed with levels at 122.5, 396.7, 738, 859, 921, 952, 1046, 1150, 1247, 1274, 1464, 1589, 1608, 1660, and 2032 keV. The results are discussed in the light of the unified model. (auth)

38254 NUCLEAR CHARGE DISPERSION OF LIGHT-MASS FISSION PRODUCTS IN THE FISSION OF ^{235}U AND ^{238}U BY MEDIUM-ENERGY PROTONS. Khan, A. H.; Saha, G. B.; Yaffe, L. (McGill Univ., Montreal). Can. J. Chem.; 48: 1924-33(15 Jun 1970).

Independent fission yields for ^{90m}Y, $^{90m+g}$Y, ^{91m}Y, $^{91m+g}$Y, and ^{92}Y and cumulative yields for ^{91}Sr, ^{92}Sr, and ^{93}Y in the fission of ^{235}U and ^{238}U by protons of energy from 20 to 85 MeV were determined. Excitation functions and charge dispersion curves were obtained. The most probable charge, Z_p, moves closer to stability, Z_A, with increasing energy. The values of $Z_A - Z_p$ for the two fissioning systems are identical, unlike the situation in the heavy-mass region. The values of $Z_A - Z_p$ for the light- and heavy-mass regions differ considerably, showing that the equal charge displacement hypothesis does not hold even at these moderate energies. (auth)

38255 MEASUREMENTS CONCERNING THE DECAY OF ^{177}Lu. Fleck, C. M.; Niederstaetter, W. (Oesterreichische Hochschule, Vienna). Atomkernenergie; 15: 269-70(1970).

The low energy γ-ray spectrum of Lu following thermal neutron capture was investigated. Several new transitions could be discovered. The energies of all the lines were defined with an accuracy of ±0.8 keV. Furthermore, the lifetime of a short-lived transition in ^{177}Lu was measured by pulse activation with thermal neutrons. The half-life of this delayed transition was found to be $T_{\frac{1}{2}} = 145 \pm 5$ μs with an energy of 458.5 ± 0.8 keV. (auth)

38256 HELIUM ION-INDUCED FISSION OF ^{204}Pb AT 65, 41, 37, AND 25 MeV. Hensley, W. K.; Neuzil, E. F. (Western Washington State Coll., Bellingham). J. Inorg. Nucl. Chem.; 32: 1761-6(Jun 1970).

A radiochemical study was made of the 65, 41, 37, and 25 MeV helium ion-induced fission of ^{204}Pb. The fission fragment mass distribution curves are primarily gaussian in shape with widths at half maximum of 20, 19, 18 and 11 a.m.u. respectively. Total fission cross sections obtained for 65, 41, 37, and 25 MeV were

47,000, 1824, 320 and 18 μ barns respectively. Charge distribution determinations made for masses 92 and 112 at 41 and 37 MeV indicated a significant correction factor at 41 MeV. (auth) (UK)

38257 TOTAL NEUTRON CROSS-SECTIONS OF Tb, Dy, Ho, Er, Tm, AND Lu FOR SUBTHERMAL NEUTRON ENERGIES OF 0.1 TO 3 MeV. Knorr, K.; Schmatz, W. (Technische Hochschule, Munich. Kernforschungsanlage, Juelich, Ger.). Atomkernenergie; 16: 49-54(1970). (In German).

Total cross sections were measured for neutron energies between 0.1 and 3 MeV with a mean accuracy of 2%. The samples were analyzed carefully for impurities with high cross sections like Gd. For calculation of the absorption cross section the inelastic paramagnetic cross section was measured and compared with theory. Values for the absorption cross sections are in good agreement with standard values at thermal energies. (auth)

38258 TWO PARAMETER CENTROID SHIFT METHOD FOR MEASURING NUCLEAR LIFETIMES. Boulter, J. F.; Prestwich, W. V.; Arad, B. (McMaster Univ., Hamilton, Ont.). Nucl. Instrum. Methods; 83: 29-34(1970).

A delayed coincidence technique for measuring nuclear lifetimes in the range of 100 ps is described. The start-stop time interval is recorded along with the stop energy in a two parameter array S(E,t) and the shape of the centroid-energy function $\langle S(E,t)\rangle$ in the prompt region of the spectrum is determined and extrapolated to the delayed region in order to obtain the centroid shift. The lifetime of the 31.2 keV level in ^{28}Al – $T_{\frac{1}{2}}$ = 2.15 ± 0.06 ns and of the 279 keV level in ^{203}Tl – $T_{\frac{1}{2}}$ = 282 ± 15 ps have been measured using this method. As a more direct verification of the technique, a source was displaced through measured distances relative to a second fixed source and the observed centroid shifts compared to the values predicted using the speed of light. (auth)

38259 SUPERHEAVY NUCLIDES. II. POSSIBILITY OF DETECTING SUPERHEAVY NUCLIDES THROUGH THEIR DECAY PRODUCTS. Zaduban, M. (Univ., Mainz). Inorg. Nucl. Chem. Lett.; 6: 391-8(1970). (In German).

Decay series are given for three nuclides (^{293}108, ^{293}109 and ^{294}110) having half-lives so long that they might still be detectable through their decay products. Three ways of detecting these for ^{293}109 in minerals are stated. The results may explain the anomalous abundance values for Pb, Bi, Th and U, and also for elements in the range 45 < Z < 73. (UK)

38260 ABOUT PERTURBATIONS OF THE ANGULAR CORRELATION OF THE ^{129}I 459.7 TO 27.7-keV CASCADE γ-QUANTA IN THE POLYCRYSTALLINE SOURCES. Makaryunas, K. V.; Makaryunene, E. K.; Daukantaite, O. K. (Inst. of Physics and Mathematics, Vilnyus, USSR). Liet. Fiz. Rinkinys, Liet. TSR Mokslu Akad., Liet. TSR Aukst. Mokyklos; 9: 597-603(1969). (In Russian).

The angular correlations of the 459.7 – 27.7 keV ^{129}I γ-rays, emitted after β-decay of the tellurium-129, were investigated with different polycrystalline sources. The strong perturbations of the integral angular correlations in the cubic structure crystals were observed. It is supposed that these perturbations are connected with some interactions, which arise as the result of the recoil of the nucleus in the β-decay. The results of these investigations show that angular correlation of the 459.7 – 27.7 keV ^{129}I γ-rays in crystals can be perturbed by interactions which are different from the static quadrupole interaction of a nucleus in the crystal lattice in the normal site and in a normal surrounding. (auth)

38261 DECAY OF ^{117m}Sn. Kalinauskas, R. A.; Makaryunas, K. V.; Davidonis, R. I. (Inst. of Physics and Mathematics, Vilnyus, USSR). Liet. Fiz. Rinkinys, Liet. TSR Mokslu Akad., Liet. TSR Aukst. Mokyklos; 9: 583-95(1969). (In Russian).

Spectra of internal conversion electrons and gamma-rays of ^{117m}Sn were investigated using a prismatic iron-magnet beta-spectrometer and a NaI(Tl) scintillation gamma-ray spectrometer. The following energy values of the gamma-transitions of ^{117m}Sn were found (keV): 156.0 ± 0.1 and 158.6 ± 0.1. The absence of the transition with energy 314.6 keV was noted (it's intensity less than 0.0005 relative to the full number of the decays). On the basis of these experimental results the upper limit of the competitive E5 (314.6 keV) and M4 (156.0 keV) radiative transitions matrix elements square ratio was estimated: $M^2_{E5}/M^2_{M4} \leq 0.01$. The following relative intensities of the internal conversion electron lines and the values of the conversion coefficients were measured: for the 156.0 keV transition — K : L : M : (N ± 0) = (243 ± 4) : 100 : (21.5 ± 0.5) : (3.3 ± 0.3), $L_I : L_{II} : L_{III}$ = (49.8 ± 1.6) : (10.7 ± 0.56) : (39.5 ± 1.5), and for the 158.6 keV transition — K : L = 7.13 ± 0.5, α_K = 0.131 ± 0.005, α_L = 0.018 ± 0.002. The experimental results are compared with theoretical results of Sliv, Band, and Rose. (auth)

38262 SUPERHEAVY NUCLIDES. I. THEORETICAL POSSIBILITIES OF THE EXISTENCE OF DECAY SERIES. Zaduban, M. (Univ., Mainz). Inorg. Nucl. Chem. Lett.; 6: 381-9(1970). (In German).

Conditions governing the theoretically possible decay series for nuclides near the "stability line" are stated. The total number of alpha decays in a series is evaluated. The problem of getting through the "fission barrier" is discussed. The results may explain the anomalous abundance values for Pb, Bi, Th and U, and also for elements in the range 45 < Z < 73. (UK)

38263 ENERGY-DEPENDENT BETA-GAMMA CIRCULAR POLARIZATION OF ^{140}La. Ohlms, D. E.; Bosken, J. J.; Simms, P. C. (Purdue Univ., Lafayette, Ind.). Contract AT(11-1)-1746. Phys. Rev., C; 1: 1803-9(May 1970).

The β-γ circular polarization P_γ was measured as a function of the β-particle energy for ^{140}La and for ^{60}Co. The ^{60}Co results confirm that P_γ is proportional to v/c. The results for the 2.2-MeV transition of ^{140}La show that the original prediction for the vector-matrix-element ratio is not correct for this transition. However, the results are consistent with predictions based on the conserved-vector-current (CVC) theory if the approach suggested by Damgaard and Winther is followed. This interpretation yields information on third-forbidden matrix elements. (auth)

38264 THE DECAY OF ^{91m}Mo AND OF ^{91g}Mo. Hesse, K.; Finckh, E. (Technische Hochschule, Darmstadt, Ger.). Nucl. Phys.; A141: 417-22(1970).

The decay of ^{91}Mo was investigated using a Ge(Li) spectrometer. γ-ray energies and intensities are determined. The energies of the levels of ^{91}Nb, known from nuclear reactions, at 104.5, 1186.8, 1312.7, 1580.9, 1612.5, 1636.9, 1790.5, 1844.9, 2631.4 and 3148.7 keV were determined more precisely. New levels are proposed at 2530.8, 2791.8, 3027.7, 3148.7, 3187.1, 3837.2, 3886.3, 3916.3, and 4179.2 keV. No levels were found at 350 or 1070 keV. (auth)

38265 PRECISE ATOMIC MASS DIFFERENCES AND MASS SYSTEMATICS IN THE REGION OF 90 NEUTRONS. Macdougall, J. D.; McLatchie, W.; Whineray, S.; Duckworth, H. E. (McMaster Univ., Hamilton, Ont.). Nucl. Phys.; A145: 223-43(1970).

A large double-focussing mass spectrometer was used to determine twenty atomic mass differences involving isotopes of Pr, Nd, Sm, Eu and Gd. The new mass differences were combined with existing reaction and decay data to calculate nucleon separation and pairing energies for many nuclei in the region of 90 neutrons. These nucleon separation and pairing energies were used to study the irregularities in mass systematics which result from the establishment of nuclear deformation. The discontinuities in the mass systematics near N = 90 follow closely the changes observed in studies of nuclear excited state systematics, quadrupole moments and optical isotope shifts. (auth)

38266 NEW ATOMIC MASS DIFFERENCES AND MASS SYSTEMATICS IN THE REGION 100 ≤ N ≤ 126. McLatchie, W.; Whineray, S.; Macdougall, J. D.; Duckworth, H. E. (McMaster Univ., Hamilton, Can.). Nucl. Phys.; A145: 244-56(1970).

Values are reported for ten atomic mass differences involving isotopes of W, Re and Os. The new mass differences are combined with existing nuclear reaction and decay data to yield single- and double-neutron separation energies and neutron pairing energies for many nucleides in this mass region. The neutron separation energy systematics defined by the nucleides between Hf and Pb indicate that the transition from permanently deformed nuclei at N ≈ 110 to spherical nuclei at N ≈ 120 is not accompanied by a pronounced mass effect. (auth)

38267 NUCLEAR LEVELS OF ^{237}U EXCITED BY THE (^{3}He,α) REACTION. von Egidy, T.; Elze, Th. W.; Huizenga, J. R. (Univ. of Rochester, N. Y.). Nucl. Phys.; A145: 306-18(1970).

The ^{238}U(^{3}He,α)^{237}U reaction was studied with a 30-MeV ^{3}He beam. Transferred angular momenta and spectroscopic factors were determined. Theoretical spectroscopic factors were calculated including Coriolis band mixing. By comparison of both the measured and calculated spectroscopic factors and the experimental and theoretical (DWBA) angular distributions of the emitted alpha particles, the following Nilsson levels were identified in ^{237}U: $\frac{1}{2}$, $\frac{7}{2}$, $\frac{5}{2}$, $1\frac{1}{2}$[631↓]; $\frac{5}{2}$, $1\frac{1}{2}$, ($1\frac{3}{2}$) [622↑]; $1\frac{1}{2}$, ($1\frac{3}{2}$), $1\frac{5}{2}$[743↑]; ($1\frac{1}{2}$[624↓]); $\frac{5}{2}$, $1\frac{1}{2}$[631↑]; $\frac{5}{2}$, $1\frac{1}{2}$, $1\frac{3}{2}$[633↓]; and $1\frac{5}{2}$[752↑]. Weak transitions to members of the [501↓] band were observed. Additional tentative assignments are discussed. (auth)

38268 COMPARISON BETWEEN THE QUASIPARTICLE TAMM-DANCOFF AND RANDOM-PHASE APPROXIMATIONS IN EVEN TIN ISOTOPES USING REALISTIC INTERACTIONS. Gmitro, M. (International Centre for Theoretical Physics, Trieste, Italy); Rimini, A.; Rossi, P.; Weber, T. Phys. Rev., C; 1: 1801-3(May 1970).

The quasiparticle Tamm-Dancoff and random-phase approximations were applied to ^{116}Sn and ^{120}Sn using realistic shell-model interactions derived from the Tabakin and Yale-Shakin potentials. It is found that the two approximations are very similar for both spectra and nuclear states. (auth)

38269 BETA-DECAY MATRIX ELEMENTS OF ^{140}La AND THE IMPLICATIONS FOR ISOBARIC ANALOG STATES. Smith, H. A.; Simms, P. C. (Purdue Univ., Lafayette, Ind.). Contract AT(11-1)1746. Phys. Rev., C; 1: 1809-19(May 1970).

Experimental data are used to determine the first-forbidden matrix elements for the 2.2-MeV β transition of ^{140}La. The results show that the matrix-element ratio $(\int\alpha/\int ir)$ does not agree with the usual theoretical prediction which assumes the Ahrens-Feenberg approximation. The size of the experimental vector-matrix-element ratio can be understood on the basis of significant off-diagonal contributions in the Coulomb Hamiltonian. The theory of conserved vector current is used to investigate impurities in the isobaric analog to the ground state of ^{140}La. In addition, the contribution of third-forbidden matrix elements to the transition is investigated. (auth)

38270 SEARCH FOR SPONTANEOUSLY FISSIONING ELEMENTS IN NATURE. Price, P. B. (General Electric Research and Development Center, Schenectady, N. Y. Univ. of California, Berkeley); Fleischer, R. L.; Woods, R. T. Phys. Rev., C; 1: 1819-21(May 1970).

The failure to observe fission tracks in old Pb-rich and Au-rich minerals restricts the spontaneous fission rates of Au and Pb to $\lesssim 1\times10^{-25}$ per year per Au atom and $< 3\times10^{-24}$ per year per Pb atom (at 95% confidence level). No fission-track evidence for superheavy elements in these or other minerals rich in heavy elements was found. These negative results are not compatible with recent proportional-counter data and track data of Flerov and co-workers. (auth)

38271 MEAN LIFETIMES OF THE SECOND 0^+ STATES IN ^{92}Zr AND ^{94}Zr. Cochavi, S.; Cue, N.; Fossan, D. B. (State Univ. of New York, Stony Brook). Phys. Rev., C; 1: 1821-5 (May 1970).

The lifetimes of the 1.38-MeV 0^+ state in ^{92}Zr and the 1.30-MeV 0^+ state in ^{94}Zr were measured by a particle-γ delayed coincidence technique. These states were excited with the (p,p') reaction at proton analog-resonance energies of 7.90 MeV for ^{92}Zr and 8.12 MeV for ^{94}Zr. The mean lifetimes obtained from the logarithmic slope of the time spectra are $\tau = 240 \pm 40$ psec for the 1.380-MeV state in ^{92}Zr and $\tau = 462 \pm 30$ psec for the 1.30-MeV state in ^{94}Zr. For both of these measurements the prompt-resolution function was obtained simultaneously with the 0^+ decay curve by observing the short-lived time spectrum for the first excited 2^+ state. (auth)

38272 HALF-LIVES AND GAMMA-RAY ABUNDANCES OF SEVERAL RARE-EARTH NUCLIDES. Chu, Y. Y.; Franz, E. M.; Friedlander, G. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., C; 1: 1826-8(May 1970).

New half-life values are given for ^{145}Eu, ^{146}Gd, ^{149}Eu, ^{151}Tb, ^{153}Sm, ^{153}Tb, ^{153}Dy, ^{155}Tb, and ^{155}Dy. Absolute abundances are reported for prominent γ rays associated with the decay of ^{143}Pm, ^{146}Gd, ^{149}Pm, ^{149}Eu, and ^{153}Dy. (auth)

38273 PROTON PARTICLE-HOLE STATES IN ^{208}Pb. McClatchie, E. A.; Glashausser, C.; Hendrie, D. L. (Univ. of California, Berkeley). Phys. Rev., C; 1: 1828-34(May 1970).

The structure of ^{208}Pb was investigated using the ^{209}Bi(d,^{3}He)^{208}Pb reaction at 50 MeV. Angular distributions were measured from 10-50° lab for 15 levels in ^{208}Pb. These states in ^{208}Pb are considered to be populated through their $[1h_{9/2},(nlj)^{-1}]$ proton particle-hole components. Spectroscopic factors were extracted for each state and compared with those predicted by a recent random-phase-approximation calculation of Kuo and Brown. Generally good agreement between theory and experiment results. (auth)

38274 DECAY OF ^{109}Sn AND THE LEVEL STRUCTURE OF ^{109}In. Shastry, S. (State Univ. of New York, Plattsburgh. Yale Univ., New Haven); Bakhru, H.; Ladenbauer-Bellis, I. M. Phys. Rev., C; 1: 1835-44(May 1970).

The excited levels of ^{109}In were investigated from the decay of ^{109}Sn with high-resolution Ge(Li) and Si(Li) detectors and with standard scintillation counters. ^{109}Sn was produced by the (α,n) reaction on enriched ^{106}Cd. γ rays of the following energies (in keV) and intensities were assigned to the decay of ^{109}Sn: 119(<1), 223(~2), 330.5(17.1), 335(4.5), 345(3), 390(6.4), 437(4.6), 442(5), 526(5.5), 609(2), 649.5(68), 725(1.5), 790(~2), 839(0.7), 843(0.6), 872(~1), 950(<1), 1028(17.8), 1037(12.7), 1098(100), 1120(9.1), 1221(0.7), 1321(37.4), 1443(1.8), 1465(33.8), 1488(17.8), 1497(~1), 1574(18.8), 1618 and 1622(2.5), 1688(2.0), 1712(1.9), 1729(2.6), 1741(1), 1762 (3.5), 1823(1.5), 1841(<1), 1912(15.5), 1930(1.4), 1935(0.3), 1944 (3.1), 1952(0.3), 1963(0.1, 1976(0.2), 2053(5.8), 2126(3.6), 2160(2.3), 2193(3.7), 2275 and 2278(1.6), 2349(<1), 2541(7.9), 2595(1.5), 2786 (3.9), 2811(0.8), 2860(2.3), 2939(0.27), 3010(0.37), 3033(0.37), 3050 (0.97), 3062(0.23), 3074(0.08), 3314(0.22), 3360(0.07), and 3393 (0.35). The use of two Ge(Li) detectors in coincidence studies has revealed the presence of several previously unreported transitions. Based on γ-γ and β-γ coincidence results, a consistent level scheme of ^{109}In is given. The spin and parity assignments of some of the low excited levels of ^{109}In are discussed. (auth)

38275 NEW HIGH-SPIN ISOMER ^{179m}Hf AND INTRABAND BRANCHINGS IN THE GROUND-STATE ROTATIONAL SEQUENCE OF ^{179}Hf. Huebel, H. (Princeton Univ., N. J.); Naumann, R. A.; Andersen, M. L.; Larsen, J. S.; Nielsen, O. B.; Poulsen, N. O. Roy. Phys. Rev., C; 1: 1845-9(May 1970).

A new high-spin isomer ^{179m}Hf was produced by irradiation of isotopically enriched ^{176}Yb with α particles. To investigate its decay, Ge(Li) γ-ray spectra, Si(Li) conversion-electron spectra, and NaI(Tl)-Ge(Li) and Ge(Li)-Ge(Li) γ-γ coincidence spectra were recorded. γ rays with energies 122.7, 146.2, 169.8, 192.8, 217.0, 236.6, 257.5, 268.9, 316.0, 362.6, 409.8, and 453.7 keV were attributed to the decay of the isomer. These decay with a half-life of (29 ± 1) day. The coincidence measurements establish that the quanta with energies 122.7 through 236.6 keV are in cascade, while the γ rays with energies 268.9 through 453.7 keV represent crossover transitions within a rotational band with levels up to $I = 21/2$ built on the ^{179}Hf ground state. The rotational-model quantity $(g_K - g_R)^2/Q_0^2$ was derived from γ intensity measurements of the cascade and crossover transitions. It is constant within the experimental error for all members of the band. The values for the gyromagnetic ratios $g_K = -0.202 \pm 0.027$ and $g_R = 0.160 \pm 0.014$ were deduced. (auth)

38276 STUDY OF RADIATION WIDTHS AND NEUTRON STRENGTH FUNCTIONS OF Dy ISOTOPES. Mughabghab, S. F.; Chrien, R. E. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., C; 1: 1850-61(May 1970).

Neutron transmission measurements were carried out for ^{161}Dy, ^{162}Dy, ^{163}Dy, and ^{164}Dy, employing the fast-chopper facility of the Brookhaven Graphite Research Reactor. The s-wave neutron strength functions (S^0), resonance parameters, average level spacings, and potential-scattering radii were determined. The values of the neutron strength functions of ^{161}Dy, ^{162}Dy, ^{163}Dy, and ^{164}Dy are 1.85 ± 0.15, 2.3 ± 0.5, 1.7 ± 0.2, and 1.2 ± 0.5, all in units of 10^{-4}. The corresponding average total radiation widths of Dy isotopes are found to be 114 ± 10, 155 ± 15, 109 ± 8, and 55 ± 3 meV. A correlation between total radiation width and S^0 seems to be evident. Furthermore, examination of the present and previous results for the rare-earth isotopes indicates that there is a systematic trend of decrease of S^0 with increasing mass number for the even-even target nuclei. Absorption-resonance integrals and thermal cross sections are computed from the resonance parameters and are compared with direct measurements of other experiments. (auth)

38277 SEARCH FOR THE 0^+ MEMBER OF THE TWO-PHONON TRIPLET IN ^{110}Cd. Van Hise, James R. (Andrews Univ., Berrien Springs, Mich.); Kelley, Miquel C.; Lanier, Robert G.; Johnson, Noah R. Phys. Rev., C; 1: 1861-5 (May 1970).

Levels in ^{110}Cd were studied through the decay of ^{110g}Ag(1^+) using NaI(Tl) and Ge(Li) detectors. The following γ-ray energies (intensities in parentheses) were observed: 657.8 ± 0.2(100), 815.6 ± 0.3(0.98), 1125.9 ± 0.3(0.36), 1186.4 ± 0.7(0.056), 1421.8 ± 1.3(0.044), 1475.8 ± 1.3(0.11), 1630.0 ± 1.2(0.048), 1674.2 ± 0.9(0.15), and 1783.3 ± 1.3(0.17) keV. Coincidence measurements performed with a NaI(Tl)-Ge(Li) system showed peaks at 816 and 1126 keV in coincidence with the 657.8-keV line. The 815.6-keV peak in the singles spectrum is a doublet composed of the 818.00-keV component depopulating the 2^+ state at 1475 ± 0.05 keV and a 815.5-keV γ ray. It is proposed that the low-energy component depopulates the two-phonon, 0^+ level at 1473.2 ± 0.3 keV. A level at 1783.6 ± 0.3 keV is also assigned and estimates of log ft values to all levels are given. Using a multichannel analyzer in the multiscalar mode, the half-life of ^{110g}Ag was measured as 24.7 ± 0.7 sec. (auth)

38278 DISTRIBUTION OF K X RAYS AS A FUNCTION OF MASS AND ATOMIC NUMBER IN THE SPONTANEOUS FISSION OF ^{252}Cf. Watson, R. L. (Texas A and M Univ., College Station. Univ. of California, Berkeley); Jared, R. C.; Thompson, S. G. Phys. Rev., C; 1: 1866-75(May 1970).

Measurements of the intensities of K x rays in coincidence with fission were carried out in an experiment in which the energies of complementary fission fragment pairs and K x rays were recorded

event by event, using a multiparameter analyzer. Subsequent analysis of the data resulted in the determination of the x-ray intensities associated with intervals of fragment mass for each contributing element. Most probable charge and mass values for the emission of K x rays were determined, and it was found that these most probable masses could be used to adequately define the Z_p curve—without appreciable biasing due to details of nuclear structure. An examination of the effect of total kinetic energy on the x-ray distribution revealed a distinct enhancement of even-Z K x-ray contributions to the yields as the total kinetic energy increases. Apparent shifts in the values of most probable masses for the emission of K x rays were also observed as a function of total kinetic energy. (auth)

38279 E0 TRANSITIONS FROM $0_2^+ \rightarrow 0_1^+$ STATES IN THE Z = 82 REGION. Goldman, L. H.; Cohen, B. L.; Moyer, R. A.; Diehl, R. C. (Univ. of Pittsburgh). Phys. Rev., C; 1: 1781-6(May 1970).

Energy spectra of internal-conversion electrons following (p,2n) reactions leading to even-even final nuclei in the Z ≃ 82 region were measured. E0 transitions leading from the 0^+ member of the two-phonon triplet to the 0^+ ground state were found, and the systematics of their transition rates was studied. They compete poorly with E2 transitions to the first excited (2^+) state, and the E0 transition rapidly becomes relatively less probable with decreasing A in this region. (auth)

38280 INTERMEDIATE-COUPLING CALCULATIONS IN ODD-A BISMUTH ISOTOPES. Bradley, A. M.; Meder, M. R. (Georgia State Univ., Atlanta). Phys. Rev., C; 1: 1723-31 (May 1970).

The intermediate-coupling version of the unified model was used to calculate the properties of the low-lying levels of ^{203,205,207,211}Bi. In each case, the quadrupole oscillations of the doubly even core were coupled to the $h_{\frac{9}{2}}$ and $f_{\frac{7}{2}}$ single-particle states. Energy levels, transition rates, and magnetic dipole and electric quadrupole moments were calculated for these four nuclei. Agreement between calculated nuclear properties and available experimental data is good for ^{205,207,211}Bi, but ^{203}Bi does not appear to fit within the framework of the intermediate-coupling model. (auth)

38281 ANALOG RESONANCES AND POLARIZATION. Harney, H. L. (Max Planck Institut fuer Kernphysik, Heidelberg); von Brentano, P.; Grosse, E.; Escudie, J. L.; Faivre, J. C.; Foissel, P.; Gosset, J.; Mayer, B.; Papineau, L. Nucl. Phys.; A145: 282-8(1970).

The analyzing power of elastic and of inelastic proton scattering to the first three excited states of ^{208}Pb was measured in the energy region of the $g_{\frac{9}{2}}$ analog resonance at E_p = 14.91 MeV in ^{209}Bi. The analyzing power is found to vanish, if there is no interference between direct and resonance scattering. The information which can be obtained from the polarization produced in resonance reactions is discussed. (auth)

38282 A HIGHLY EXCITED ISOMERIC STATE IN ^{117}Sb. Heiser, C.; Brinckmann, H. F.; Fromm, W. D.; Hagemann, U. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Nucl. Phys.; A145: 81-8(1970). (In German).

The decay of an isomer in ^{117}Sb with a half-life of 340 μs and an excitation energy of about 3.1 MeV was observed by bombarding ^{115}In with a pulsed beam of α-particles. The construction of the decay scheme, which contains 24 γ-transitions, is based on measurements of prompt and delayed γ-spectra, on γγ-coincidence experiments and on observation of delayed conversion electrons. For the investigations Ge(Li), NaI(Tl) and Si(Li) detectors were used. The isomeric state is probably a three-particle state with the configuration $[nn(h_{\frac{11}{2}})^2_{9+}, p(d_{\frac{5}{2}})]_{\frac{27}{2}+}$. The isomeric transition itself, which certainly has a low energy and a high conversion coefficient, has not yet been observed. (auth)

38283 MEASUREMENT OF PROMPT NEUTRON FISSION YIELD ($\bar{\nu}_p$) IN THERMAL NEUTRON FISSION OF ^{233}U, ^{239}Pu, ^{241}Pu, ^{241}Am, ^{242m}Am, ^{243}Cm, ^{245}Cm AND IN SPONTANEOUS FISSION OF ^{244}Cm. Jaffey, A. H.; Lerner, J. L. (Argonne National Lab., Ill.). Nucl. Phys.; A145: 1-27(1970).

The prompt neutron fission yield ($\bar{\nu}_p$) has been measured in thermal neutron fission of ^{233}U, ^{239}Pu, ^{241}Pu, ^{241}Am, ^{242m}Am, ^{243}Cm, ^{245}Cm and in the spontaneous fission of ^{244}Cm. A coincidence method yielded ratios to the $\bar{\nu}_p$ values of the standards ^{233}U, ^{235}U, ^{239}Pu and ^{252}Cf, with fission fragments detected in an ionization chamber at close to 100% efficiency, and with fission neutrons detected using four ZnS(Ag) methyl methacrylate discs (Hornyak buttons). The small variation of neutron detection efficiency with fission neutron spectrum differences was calibrated with the four standard nuclides. (auth)

38284 MEASUREMENT OF HALF DECAY TIMES OF THE FIRST EXCITED 2^+ STATES OF ^{184,186,188}Os. Bedike, T.; Zaitseva, N. G.; Morozov, V. A.; Muminov, T. M.; Seledzheanu, S. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 11: 481-2(Mar 1970). (In Russian).

The half-lives of the first 2^+ states of ^{184,186,188}Os are determined by the method of delayed coincidences. The values of $T_{\frac{1}{2}}$ were found to be: for the level 119.8 keV in ^{184}Os—$(1.18 \pm 0.05) \cdot 10^{-9}$ sec, for the level 137.2 keV in ^{186}Os—$(0.84 \pm 0.05) \cdot 10^{-9}$ sec, for the level 155.0 keV in ^{188}Os—$(0.71 \pm 0.03) \cdot 10^{-9}$ sec. (auth)

38285 DIFFERENT CONTRIBUTIONS OF DIRECT AND COLLECTIVE CAPTURE IN (p,γ) AND (n,γ) REACTIONS. Longo, G.; Saporetti, F. (Comitato Nazionale per L'Energia Nucleare, Bologna). Nuovo Cim.; 67A: 356-68(21 May 1970).

For each transition of the ^{208}Pb(p,γ) and ^{208}Pb(n,γ) reactions the partial direct and collective cross sections are obtained for 6 to 30 MeV nucleon energies. The radial, energy and angular momentum dependence of matrix elements is investigated and explained by means of considerations on the Coulomb and the centrifugal repulsion influences. It is found that in the 10 to 20 MeV energy region the direct capture of protons is favored with respect to that of neutrons, while the opposite is true for collective capture. The theoretical predictions of direct and collective models for the two kinds of nucleons are in qualitative agreement with the available (n,γ) and (p,γ) experimental data. (auth)

38286 INVESTIGATION OF MANY-NUCLEON TRANSFER REACTIONS INDUCED BY HEAVY IONS ON NUCLEI IN INTERMEDIATE MASS REGION. Oganesyan, Yu. Ts.; Penionzhkevich, Yu. E.; So Ki Hwang; Shamsutdinov, A. O.; Mal'tseva, N. S.; Chuburkova, I. I. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 11: 492-500(Mar 1970). (In Russian).

Production of Sb, I, Cs, Ba, Ce isotopes in target nuclei ^{133}Cs, ^{127}I, ^{139}La, ^{141}Pr as a result of many-nucleon transfer reactions was investigated. A Ge(Li) γ spectrometer combined with a 4096-channel amplitude analyzer was used for the identification. Distribution of transfer and stripping cross sections for various numbers of the neutrons is shown to be described by a Gaussian function. The obtained data are discussed in view of possible use of the many-nucleon transfer reactions for synthesis of isotopes far outside the stability region. (auth)

38287 KINETIC ENERGIES AND MASS DISTRIBUTIONS OF FRAGMENTS OF ^{244}Cm SPONTANEOUS FISSION. Alkhazov, I. D.; Kostochkin, O. I.; Kovalenko, S. S.; Malkin, L. Z.; Petrzhak, K. A.; Shpakov, V. I. Yadern. Fiz.; 11: 501-7(Mar 1970). (In Russian).

Kinetic energies of pair fragments of the ^{244}Cm spontaneous fission were measured by means of surface-barrier Si detectors. The energy was calibrated by the Schmitt method. $65 \cdot 10^3$ spontaneous fissions were detected. Event distribution contour graphs were obtained which made it possible to determine the dependence of the mean summary kinetic energies, dispersions of kinetic energies on the masses of fragments, of intermediate masses and dispersions of mass distributions on the summary kinetic energy, etc. Distributions of masses and of summary kinetic energies of fragments are also given. It is pointed out that the masses 134, 136, 137, 140 and 146 are dominant in some regions of variation of the summary kinetic energies. The results obtained are compared with analogous data for neighboring fissible nuclei. (auth)

38288 PHOTOFISSION OF ^{232}Th, ^{235}U, ^{238}Pu, ^{240}Pu, ^{242}Pu AND STRUCTURE OF THE FISSION BARRIER. Rabotnov, N. S.; Smirenkin, G. N.; Soldatov, A. S.; Usachev, L. N.; Kapitsa, S. P.; Tsipenyuk, Yu. M. Yadern. Fiz.; 11: 508-27(Mar 1970). (In Russian).

Results of measurements of angular distributions and of fragment yields in photofission of ^{232}Th, ^{238}U, ^{239}Pu, ^{240}Pu and ^{242}Pu near the threshold are given. The measurements were performed on the γ-quanta beam from the 12-MeV microtron of the Institute of Physical Problems of the USSR Academy of Sciences with the maximum energies from 5 up to 10 MeV. The calculation of the bremsstrahlung spectrum of a 1 mm tungsten target which was used to reconstruct the dependence of the photofission total cross section and its angular components on the γ-quanta energy is described. Experimental results which are beyond the framework of conventional ideas are in the favor of the two-peak fission barrier. (auth)

38289 ENERGY LEVELS IN ^{151}Eu AND ^{153}Eu. Zavadil, D. A.; Graetzer, R. (Pennsylvania State Univ., University Park). Nucl. Phys.; A146: 259-72(1970).

Energy levels of ^{151}Eu and ^{153}Eu were populated by Coulomb excitation with 12-MeV alpha particles. Alpha particles scattered

at 110 and 145° were analyzed in a magnetic spectrograph. Levels were located in ^{151}Eu at these energies: 195, 313, 511, 580, 604, 718, 775 810(?), 900 (multiplet), 963 and 1106 keV. In ^{153}Eu levels were located at 87, 194, 487(?), 572, 627 and 717 keV. Reduced transition probabilities were also determined. The level energies are consistent with new $(\alpha,\alpha'\gamma)$ and (d,d') data, but a clear interpretation of excited levels of the europium isotopes has not been established. (auth)

38290 INVESTIGATION OF PROMPT NEUTRONS ACCOMPANYING SPONTANEOUS TERNARY FISSION OF ^{252}Cf. Piekarz, H. (CERN, Geneva); Blocki, J.; Krogulski, T.; Piasecki, E. Nucl. Phys.; A146: 273-87(1970).

The properties of prompt neutrons accompanying spontaneous ternary fission (with an alpha particle as a third fragment) of ^{252}Cf were studied. The angular distributions of neutrons with respect to the flight direction of the fission fragment were measured for both the ternary and the binary fission. The number of neutrons and the yield ratio of neutrons emitted from the light and heavy fragments in ternary fission were determined by comparison with those observed in binary fission. The neutron yield as a function of the kinetic energy of the α-particle was also obtained. The conclusions concerning the origin of prompt neutrons accompanying ternary fission, the excitation energy of pre-neutron emission fragments, and the energy required to release α particles during fission are discussed. (auth)

38291 ANGULAR CORRELATION MEASUREMENTS ON ^{191,193}Ir FOLLOWING COULOMB EXCITATION. Avida, R.; Ben Zvi, I.; Gilad, P.; Goldberg, M. B.; Goldring, G.; Speidel, K. H.; Sprinzak, A. (Weizmann Inst. of Science, Rehovoth, Israel). Nucl. Phys.; A147: 200-4(1970).

Magnetic dipole matrix elements for low-lying positive parity states in ^{191}Ir and ^{193}Ir were measured by angular correlations following Coulomb excitation. The results are compared to previous measurements and discussed in the light of the core excitation model. (auth)

38292 ENERGY LEVELS OF ^{91}Nb, ^{93}Mo, ^{95}Tc, AND ^{97}Tc VIA (p,n) REACTIONS AND THE REACTION Q-VALUES. Kim, H. J.; Robinson, R. L.; Johnson, C. H.; Raman, S. (Oak Ridge National Lab., Tenn.). Nucl. Phys.; A142: 35-48(1970).

The (p,n) reactions on isotopically enriched targets of ^{91}Zr, ^{95}Mo, and ^{97}Mo and monoisotopic ^{93}Nb were investigated for a bombarding energy range 4 to 5.4 MeV. The neutron groups populating the low-lying excited states of ^{91}Nb, ^{93}Mo, ^{95}Tc, and ^{97}Tc were studied by the use of a time-of-flight system. The reaction Q-values for ^{91}Zr, ^{95}Mo and ^{97}Mo target nuclei were determined to be -2.045 ± 0.006, -2.490 ± 0.006, and -1.128 ± 0.008 MeV, respectively. Many low-lying states were populated by these reactions and their excitation energies determined with a high precision. (auth)

38293 GAMMA TRANSITIONS AND EXCITED STATES OF NEUTRON-DEFICIENT EVEN LEAD NUCLEI. Hanser, A. (Kernforschungszentrum, Karlsruhe, Ger.). Nucl. Phys.: A146: 241-58(1970). (In German).

Gamma-transitions in the nuclei ^{202}Pb, ^{200}Pb, and ^{198}Pb were observed by investigating the decays of the short-lived nuclides ^{202}Bi, ^{200}Bi, and ^{198}Bi. Gamma-ray energies, relative γ-intensities, K-conversion coefficients, and K/L conversion ratios were measured using semiconductor detectors. Coincidences of sufficiently strong transitions were studied with NaI(Tl) detectors. As far as possible, the observed γ-transitions have been placed in proposed level schemes. The bismuth nucleides had been produced by cyclotron irradiation of lead and thallium and isolated by electromagnetic and chemical separation procedures. (auth)

38294 NUCLEAR g-FACTOR MEASUREMENTS OF TWO SHORT-LIVED STATES IN ^{206}Pb. Zawislak, F. C.; Bowman, J. D. (California Inst. of Tech., Pasadena). Contract AT(04-3)-63. Nucl. Phys.: A146: 215-19(1970).

The $\gamma-\gamma$ perturbated angular correlation method has been used to measure the nuclear g-factors of the states at 803 and 2385 keV in ^{206}Pb. Employing the large internal magnetic field acting on Pb is an Fe host it was found that $g(803\text{ keV}, 2^+) = 0.01 \pm 0.07$ and $g(2385\text{ keV}, 6^-) = +0.13 \pm 0.07$. These values are compared with calculations based on two-neutron hole wave functions reported in the literature. (auth)

38295 LEVELS IN ^{119} ^{121} ^{123}Te. Spejewski, E. H.; Hopke, P. K.; Loeser, F. W. Jr. (Princeton Univ., N. J.). Nucl. Phys.; A146: 182-92(1970).

The decays of ^{119,121,123}I have been studied using isotopically separated sources produced by proton spallation of lanthanum. The Ge(Li) γ-ray singles spectra and Ge(Li)–Ge(Li) coincidence spectra have been obtained and used in constructing level schemes for the corresponding tellurium daughters. (auth)

38296 GAMMA-RAY STUDIES OF THE DECAY OF MASS-SEPARATED ^{92}Y. Talbert, W. L. Jr. (Ames Lab., Iowa); Wohn, F. K.; Hsu, H. H.; Hsue, S. T. Nucl. Phys.; A146: 149-62(1970).

The levels of ^{92}Zr populated in the beta decay of ^{92}Y have been studied through the use of Ge(Li) detectors, both in singles and coincidence. Nineteen gamma rays have been observed and placed in a decay scheme involving eleven excited levels in ^{92}Zr. Spin-parity assignments for the excited levels in ^{92}Zr are discussed in terms of observed gamma-ray transition branching and results from nuclear reaction studies. The resulting level scheme is discussed in relation to recent theoretical treatments based on a shell-model description. (auth)

38297 ACTIVATION CROSS-SECTIONS OF Nd ISOTOPES FOR 14 MeV NEUTRONS. Cuzzocrea, P.; Perillo, E. (Istituto Nazionale di Fisica Nucleare, Naples. Univ., Naples). Nuovo Cim.; 68A: 6-10(1 Jul 1970).

Activation cross sections for (14.0 ± 0.2) MeV neutrons were measured for neodymium isotopes. The results are in good agreement with the predictions of the statistical model, when Q-values, pairing effects, and Coulomb barrier are taken into account. (auth)

38298 STRUCTURE OF Pt NUCLEI. II. STRUCTURE OF ^{192}Pt INVESTIGATED BY ELECTRON–GAMMA AND GAMMA–GAMMA DIRECTIONAL CORRELATIONS. Hirose, T.; Morinobu, S.; Ikegami, H. (Tokyo Inst. of Tech.). Nucl. Phys.; A146: 220-40(1970).

Electron-gamma and gamma-gamma directional correlation experiments are performed for various cascades in ^{192}Pt by means of a sector-type double focussing beta-ray spectro-goniometer. The ratio of the E0 and E2 nuclear matrix element between the second 2_2^+ and first 2_1^+ states is determined to be $-(6 \pm 8) \times 10^{-3}$. The penetration factors of the M1 internal conversion are obtained as follows: $0 \leq \lambda \leq 80$ for the 296 keV $(2_2^+ \rightarrow 2_1^+)$; $\lambda \approx -10$ for the 308 keV $(3^+ \rightarrow 2_2^+)$; $-35 \leq \lambda \leq 5$ for the 605 keV $(3^+ \rightarrow 2_1^+)$ transitions. The M1/E2 mixing ratios in the 296, 308 and 605 keV transitions are determined as -0.18 ± 0.04, -0.09 ± 0.09 and 0.30 ± 0.05, respectively. The new 1091 keV state is established from gamma-ray measurements with a Ge(Li) detector and the log ft values of beta transitions are derived from the intensity valence of the gamma-rays. The spin and parity are confirmed to be 3^- for the 1380 keV state. A new level scheme of ^{192}Pt is presented and the level structure of the lower excited states is discussed from the view point of collective vibrational models. (auth)

38299 LINEAR RISING TRAJECTORIES IN THE TIME-DELAY ANALYSIS OF THE SCATTERING AMPLITUDE. Cocho, G.; Mondragon, A. (International Centre for Theoretical Physics, Trieste, Italy). Phys. Rev., D; 1: 3484-95(15 Jun 1970).

It is explicitly shown that the integration parameter in the background Regge integral can be understood as a time-delay variable, its average value being the time delay and distortion caused on a wave packet by a scatterer, as seen in the Breit system of coordinates. By means of the usual exponential Fourier transform, another time-delay variable is defined with a similar meaning for the scattering process as seen in the laboratory system of coordinates. The average over the energy of the scattering amplitude is related to a cutoff in the time-delay variables in both cases. A smooth energy variation of the scattering amplitudes corresponds to a small range of variation of the time-delay variable in the transformed amplitude. A Fourier analysis of the Veneziano-model amplitude results in a simple periodic structure in the time-delay variable. A parametrization of the scattering amplitudes in the time-delay representation is proposed, valid at high and intermediate energies. It is pointed out that the non-spin-flip pion-nucleon scattering amplitudes are consistent with such a parametrization. An interpretation of models with linearly rising trajectories in terms of multiscattering processes seems natural in the time-delay representation. (auth)

Nuclear Theory

Refer also to abstracts 37407, 37579, 37667, 37811, 37830, and 38149.

38300 (CTC-32) A MICROSCOPIC ANALYSIS FOR ELASTIC SCATTERING OF DEUTERONS AND ALPHA PARTICLES. Reeves III, Mark (Union Carbide Corp., Oak Ridge, Tenn. Computing Technology Center). Mar 1970. Contract W-7405-eng-26, 118p. Dep. CFSTI.

Thesis. Submitted to Univ. of Tennessee, Knoxville.

A model is presented for the elastic scattering of deuterons

and alpha particles. The target is assumed to have collective states which are excited by nonspherical interactions with each nucleon of the projectile. Nonlocal potentials are derived, and the elastic-channel Schroedinger equations containing these potentials are solved numerically for a ^{58}Ni target. Inelastic effects are included for both projectiles, but contributions from stripping and breakup appear only in the deuteron case. Discussion is presented to compare this work with that of other authors and to explore possible modifications which would bring the predictions of this model into closer agreement with experimental data. (auth)

38301 (IAE-1878) THE THEORY OF THE CHANNELLING EFFECT. [PART] I. Kazan, Yu.; Kononets, Yu. V. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Atomnoi Energii). 1969. 32p. (In Russian). Dep. CFSTI (U. S. Sales Only).

A method for considering the channeling effect and related phenomena, based on the use of the density matrix formalism and allowing one to single out the coherent differaction induced by regularity of the medium, is developed. In the case of plane channeling with disregarded inelastic scattering, the problem is reduced to that of the particle motion in the one-dimensional periodic potential $V_{eff}(x)$ depending on the crystal temperature. The essential role of states, the energies of which are close to the maximum values of $V_{eff}(x)$, is revealed. The question of the distance, at which the essential change of the nuclear reaction yield occurs, is analyzed. The possibility of appearance of splashes in the nuclear reaction yield with the crystal thickness is shown (a peculiar "echo"). The concrete analysis was carried out for the model potential of the Kronig-Penney type. The calculations reveal all the qualitative results, demonstrating in particular the quantum oscillations of the thickness average of the nuclear reaction yield as a function of the incidence angle. (auth)

38302 (IFA-FT-78) HARTREE-FOCK CALCULATIONS IN LIGHT NUCLEI. Guiasu, I.; Iosifescu, M.; Scutaru, H.; Cristu, M. (Academia R. S. R., Bucharest. Institutul de Fizica Atomica). 1969. 13p. Dep. CFSTI (U. S. Sales Only).

Hartree-Fock calculations for even nuclei in the 1p shell were performed by using the matrix elements of the nucleon-nucleon interaction extracted by Elliott et al. In H.F. approximation binding energies for the Elliott potential are larger than those obtained with the Tabakin potential. All solutions of the H.F. equation were obtained. The Slater determinants corresponding to the two H.F. minima in ^{12}C are very close to the solutions of an exact diagonalization of the Hamiltonian on the basis that has been used in the H.F. calculations. (auth)

38303 (ITF-70-18) MULTIPOLE ANALYSIS OF THE FAST NUCLEON SCATTERING BY NUCLEI. Sitenko, A. G.; Dotsenko, I. S.; Pursa, A. D. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1970. 30p. (In Russian). Dep. CFSTI (U. S. Sales Only).

To describe the high-energy nucleon scattering on nuclei a multipole formalism is developed. The impulse approximation is used. The cross section of nucleon scattering on nuclei is expressed through the nucleon-nucleon scattering and the form factors connected with the nuclear structure. Taking into account the charge freedom degrees of nucleons, nuclei can be described by multipoles of sixteen types. To each transition of the definite multipolarity there correspond selection rules. As an example the numerical calculations of angular distributions for elastic proton scattering on nuclei ^{12}C as well as for inelastic proton scattering with excitation of levels 2^+, 3^- and 1^+ for T = 0 and 1^+ for T = 1 of nucleus ^{12}C are carried out. (auth)

38304 (JINR-P4-5045) ON THE INVESTIGATION OF THE ATOMIC NUCLEUS STRUCTURE. Solov'ev, V. G. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1970. 11p. (In Russian). Dep. CFSTI (U. S. Sales Only).

Basic directions in the investigation of nuclear structure are presented. General attention is paid to the ways of studying the low-excited states of medium and heavy nuclei. (auth)

38305 (NP-18275) LOWER BOUND TO THE MAGNITUDE OF THE NUCLEAR BINDING ENERGIES OF DOUBLY MAGIC NUCLEI. II. VELOCITY-DEPENDENT FORCES. Note No. 254. Calogero, F.; Simonov, Yu. A. (Rome Univ. (Italy). Istituto di Fisica. Istituto Nazionale di Fisica Nucleare, Rome (Italy)). 29 Jan 1970. 56p. Dep. CFSTI (U. S. Sales Only).

This is the second of a series of papers devoted to the description of the hyperspherical expansion approach to nuclear bound states. It reports the extension to the case of velocity-dependent forces of the results of the first paper of the series, in which upper bounds were obtained for the lower energy levels of (suitably defined) doubly magic nuclei. (auth)

38306 (NP-18279) ON THE QUADRUPOLE FORCE IN NUCLEAR SPECTROSCOPY. Note No. 248. Olivieri, E. (Rome Univ. (Italy). Istituto di Fisica); Salusti, E. (Rome Univ. (Italy). Istituto di Fisica. Istituto Nazionale di Fisica Nucleare, Rome (Italy)). 19 Dec 1969. 20p. Dep. CFSTI (U. S. Sales Only).

A method for studying the features of the quadrupole interaction in deformed nuclei is discussed. A central spherical potential is developed in multipoles by an iterative procedure. As an example, calculations are performed for ^{19}F using the ^{18}O states as a basis. (J.W.R.)

38307 (NYO-2171-308) ALGEBRAIC APPROACH TO THE THEORY OF NUCLEAR STRUCTURE. Dreizler, R. M.; Klein, Abraham (Pennsylvania Univ., Philadelphia. Dept. of Physics). May 1970. 28p. (CONF-700411-2). Dep. CFSTI.

From Midwest Theory Conference, Notre Dame, Ind.

The approach to nuclear structure physics which seeks to obtain from the equations of motion and from kinematical algebraic restrictions (commutation relations, etc.) a calculus of directly observable matrix elements is reviewed in general terms. A detailed account is then given of a recent application to a model of particles in a single j level with pairing plus quadrupole-quadrupole interactions. (auth)

38308 (NYO-4032-23) LANDAU, BRUECKNER-BETHE AND MIGDAL THEORIES OF FERMI SYSTEMS. Brown, G. E. (Nordisk Institut for Teoretisk Atomfysik, Copenhagen (Denmark). State Univ. of New York, Stony Brook. Inst. for Theoretical Physics). [1969]. Contract AT(30-1)-4032. 65p. Dep. CFSTI.

The Landau theory for infinite Fermi systems is discussed, and it is then shown how one can apply the Landau technique of functional differentiation of the energy with respect to quasiparticle occupation numbers in order to obtain the effective interaction, beginning from the Brueckner-Bethe approximation to the energy. Calculations of this effective interaction by Bäckman from a nucleon-nucleon potential are discussed and criticized. Results of his calculation are compared with parameters in Migdal's effective force, evaluated at the center of the nucleus, the latter parameters having been derived phenomenologically by fitting various nuclear phenomena. There is a large discrepancy between the calculated value of the compressibility of nuclear matter and that obtained phenomenologically. The advantages of introducing a model space in order to improve the accuracy of the calculated results is discussed, and it is pointed out that such an introduction would also be advantageous in recent calculations by Barrett and Kirson of third order terms in the effective interaction; also, that a model space is effectively introduced in recent calculations with the Migdal theory when it comes to deriving the quadrupole-quadrupole interaction. Calculation of the effective force between two atoms in ^{3}He is discussed briefly, and it is pointed out that this is a much more ambitious task than in nuclear matter. Calculations carried out within the Brueckner-Bethe formalism are reviewed. (auth)

38309 (UCSD-10-P-11-104) VALIDITY OF THE STRUTINSKY SHELL CORRECTION THEORY. Lin, Wing-fai (California Univ., La Jolla, San Diego). Apr 1970. Contract AT(11-1)-Gen-10. 27p. Dep. CFSTI.

Realistic shell-model potentials are used to test Strutinsky's method. It is found that the results are strongly dependent on the shell-smearing parameter as well as the order of the curvature correction for smearing. No unambiguous values can be obtained for the shell correction, even with the effect of the continuum properly included. As a result, the Strutinsky theory should be regarded only as a recipe to be used in combination with Nilsson potentials. (auth)

38310 THRESHOLD STATES IN NUCLEAR REACTIONS. Cwiok, Stefan (Univ., Warsaw). Postepy Fiz.; 21: 69-81 (1970). (In Polish).

The micro and macrostructure of the cross section for the scattering of the nucleons by the nucleus is considered. This structure is explained on the assumption of the compound nuclei formation and the optical potential model. The formalism developed by G. N. Payne that allows consideration of the contribution of the doorway-state effect to the averaged elastic scattering cross-section is discussed. Numerical results for ^{28}Si and ^{54}Fe are given as the illustration of the discussed formalism. (auth)

38311 A SIMPLE DESCRIPTION OF ISOBARIC ANALOGUE RESONANCES BY THE AID OF RESONANT STATE WAVE FUNCTIONS. Zimanyi, J. (Central Research Inst. for Physics, Budapest); Zimanyi, M.; Gyarmati, B.; Vertse, T. Acta Phys. Acad. Sci. Hung.; 28: 251-5(1970).

The usefulness of the concept of the resonant state wave function is demonstrated in a simple description of isobaric analog resonances. (auth)

38312 RADIATIVE PION ABSORPTION AND SOFT PION THEOREMS. Fulcher, Lewis Page Jr. Charlottesville, Va.; Univ. of Virginia (1969). 137p.

Thesis.

Radiative pion absorption provides one means of studying spin-isospin collective vibrations in nuclei. These excitations are important for an understanding of nuclear muon capture. The hypotheses of a partially conserved axial-vector current and of current algebras are used to prove the Kroll-Ruderman theorem. This theorem states that the matrix elements for the radiative absorption of soft pions are those of the axial-vector current which is involved in nuclear muon capture. Partial radiative pion absorption rates for pions bound in the 1S atomic orbital are calculated treating the nucleus as an elementary particle. The relevant form factors are taken from experimental muon capture rates and electron scattering data. Total radiative pion absorption rates in light closed-shell nuclei are calculated from muon capture after using nuclear photo-excitation data in order to subtact the vector part of the latter process. Corrections to the Kroll-Ruderman theorem, which are corrections to the soft pion limit, are studied. In nuclear physics the study of corrections to the soft pion limit is especially simple since nuclear models may be employed in their calculation. We calculate corrections to the Kroll-Ruderman theorem due to the nuclear Fermi motion in the noninteracting Fermi gas model of the nucleus and find that they are small. We also calculate corrections due to the absorption of the pion employing the interacting Fermi gas model. We choose the one-pion exchange potential for the internucleon interaction. The pion-nucleon coupling constant must be readjusted in order to agree with the experimental double-nucleon emission rates. The absorptive corrections are very small. (Diss. Abstr. Int., B)

38313 INDUCED DOUBLE-NUCLEON EMISSION. II. THREE-BODY PARTIAL WAVE ANALYSIS OF (π^-,NN) IN BORN APPROXIMATION. Weber, H. J. (Univ. of Virginia, Charlottesville). Ann. Phys. (N. Y.); 57: 322-49(Apr 1970).

The absorption on ^{12}C and ^{16}O of a bound negative pion from an atomic orbital inducing the emission of two nucleons is studied. A nonrelativistic pion-nucleon interaction is used involving hydrogenic pion wave functions which are modified by strong interactions. The final-state scattering of the emitted nucleon pair in the field of the residual nucleus is investigated by means of a nonrelativistic three-body partial wave analysis. Angular correlations and energy distributions are calculated in Born approximation. An optical potential serves to describe multiple-scattering effects which are appreciable and too strong for an adequate treatment in Born approximation. Coulomb effects are neglected. The energy distributions are shown to depend strongly on the nucleon-nucleon interaction and the optical potential. (auth)

38314 MANY-ELECTRON PROBLEMS. IV. INTERNAL FIELD AND β DECAY. Gaspar, R. (Kossuth Lajos Univ., Debrecen, Hungary. Group for Theoretical Physics, Budapest). Acta Phys. Acad. Sci. Hung.; 28: 71-4(1970).

From general principles of the quantum theory an analytical formula is derived for the value of the potential field at the nucleus in neutral atoms. This may be used in the calculation of the Fermi function for β-decay. (auth)

38315 CURVATURE TERM FOR THE SHELL ENERGY OF DEFORMED NUCLEI. Schultheis, H.; Schultheis, R.; Suessmann, G. (Univ., Frankfurt am Main). Nucl. Phys.; A144: 545-57 (1970).

The shell energy of arbitrarily deformed nuclei is approximated for nuclear fission theory as a function depending on the curvature of the nuclear surface. Determining the minimal potential energy which is derived from the liquid-drop model modified by this shell term, intrinsic quadrupole moments Q_0 shell, and binding energies of about 50 nuclear ground states are calculated and compared with experimental values. (auth)

38316 MODEL CALCULATIONS OF THE ENERGY AND ANGULAR DISTRIBUTIONS OF LIGHT NUCLEI ACCOMPANYING FISSION. Kroguiski, T.; Blocki, J. (Inst. of Nuclear Research, Swierk, Poland). Nucl. Phys.; A144: 617-27(1970).

The known energy and angular distributions of light nuclei accompanying fission of heavy nuclei are transformed to the initial conditions of three-body motion treated classically, i.e., in terms of the Coulomb interaction. It is assumed that these initial conditions are closely related to the scissioning configuration of the nucleus. Hence some conclusions concerning the latter and a comparison with the predictions of the liquid-drop model are presented. (auth)

38317 HIGH EXCITED NUCLEAR STATES. Marcinkowski, Andrzej (Inst. for Nuclear Studies, Warsaw). Postepy Fiz.; 21: 41-52(1970). (In Polish).

The nuclear level density formulas for a Fermi gas and the aproximations made by its derivation were discussed. Comparison with some experimental results is given. The superiority of the superconductivity model was pointed out. (auth)

38318 SOME FEATURES OF THE DAVYDOV–FILIPPOV MODEL. Varshni, Y. P.; Bose, S. (Univ. of Ottawa). Nucl. Phys.; A144: 645-53(1970).

For the Davydov-Filippov model the two methods of calculating γ were compared. Systematics of the two parameters γ and A_{DF} are investigated. A relation due to Sheline was re-examined and a new correlation between γ/A and A_{DF} was found. (auth)

38319 INTERACTION OF α PARTICLES. Lovas, I. (Central Research Inst. for Physics, Budapest). Acta Phys. Acad. Sci. Hung.; 28: 115-20(1970).

A non-local separable potential is proposed for the description of the $\alpha-\alpha$ interaction. (auth)

38320 EFFECTIVE CENTRAL FORCES DEDUCED FROM A SIMPLE THOMAS–FERMI THEORY. Nemeth, J. (Roland Eoetvoes Univ., Budapest). Acta Phys. Acad. Sci. Hung.; 28: 53-61(1970).

Starting from realistic two-body potentials, and using the results of nuclear many-body calculations for infinite nuclei, a modified Thomas–Fermi theory supplies some effective, density dependent, central forces for overall finite nuclei property calculations. The forces were applied for determining the energy of finite nuclei. (auth)

38321 MOMENTS OF INERTIA IN ATOMIC NUCLEI. Szymanski, Zdzislaw (Univ., Warsaw). Postepy Fiz.; 21: 5-12(1970). (In Polish).

Rotational moments of inertia of atomic nuclei are discussed. Calculations based on various conceptions of the structure of nuclear rotation are reviewed. The deviations from the $I(I+1)$ rule in the rotational bands are discussed mainly in terms of the centrifugal stretching of rotating nuclei and the Coriolis antipairing effect. Possible extensions over the wider than the classical rare earth and actinide regions of nuclides are considered. (auth)

38322 THIRD AUSTRALIAN INSTITUTE OF NUCLEAR SCIENCE AND ENGINEERING NUCLEAR PHYSICS CONFERENCE, MELBOURNE, 16th–19th FEBRUARY 1970. Melbourne: Australian Institute of Nuclear Science and Engineering (1970). 88p. (CONF-700209).

Abstracts only, are presented, of various aspects of nuclear physics. High energy nuclear physics, particle physics, theoretical nuclear physics and instrumentation are among areas covered in 73 abstracts. (Australia)

38323 ON THE USE OF THE (d,p) AND (d,t) REACTIONS FOR VERIFICATION OF THE WAVE FUNCTIONS OF DEFORMED NUCLEI. Kozlowski, Miroslaw (Univ., Warsaw). Postepy Fiz.; 21: 83-95(1970). (In Polish).

The recent progress in the field of the nuclear reaction spectroscopy with (d,p) and (d,t) reaction is summarized. The role of these reactions in the experimental verification of the Nilsson Model is outlined. It was shown that the angular distribution in the stripping or pick-up reaction can be used to decomposition of the wave functions of the deformed nuclear states into their spherical components. (auth)

38324 NUCLEAR STRUCTURE AND REACTION MECHANISMS IN (p,γ) AND (n,γ) PROCESSES. Brzosko, Jan S. (Univ., Warsaw). Postepy Fiz.; 21: 97-111(1970). (In Polish).

A short description of nuclear structure data subtracted from (p,γ) and (n,γ) reactions is discussed. An explanation of the nucleon capture mechanism is given. The possibility of the giant resonance excitation is taken into account. (auth)

38325 ACCELERATORS IN NUCLEAR LEVELS STRUCTURE STUDIES. Jaskola, Marian (Inst. for Nuclear Research, Warsaw). Postepy Fiz.; 21: 113-26(1970). (In Polish).

Necessary demands put on accelerators for nuclear reaction spectroscopy measurements are summarized. Some application of the inelastic scattering of deuterons, stripping and pick-up reactions to the nuclear energy-level structure studies are presented. (auth)

38326 ONE-PARTICLE LEVELS OF MEDIUM AND HEAVY NUCLEI. Grabowski, Janusz (Inst. of Nuclear Physics, Krakow). Postepy Fiz.; 21: 13-39(1970). (In Polish).

A new method of the solution of the spherical Schroedinger

equation with a diffuse potential for bound states is described. The obtained solution is very effective and useful in calculation of the one-particle levels of the deformed nuclei and in different spectroscopic calculations. Some of these are also demonstrated. (auth)

38327 SELECTED TOPICS IN NUCLEAR STRUCTURE THEORY. Szymanski, Zdzislaw (Inst. for Nuclear Research, Warsaw. Univ., Warsaw). Postepy Fiz.; 21: 127-46(1970). (In Polish).

Three different topics in the theory of nuclear structure are discussed. In the first part the microscopic theory of nuclear vibrational levels is presented. The basic equation for the eigenfrequency of nuclear vibration is derived and its physical properties are explained. The second part deals with the generalized intensity rules in the deformed nuclei. Also the deviations from the I(I + 1) rule in nuclear rotational spectra are discussed. The third part is a discussion of the properties of the hypothetical superheavy nuclei in the region of Z = 114 and N = 184. (auth)

38328 SYSTEMATICS OF COULOMB-ENERGY DIFFERENCES OF EXCITED MIRROR NUCLEI. Everling, F. (North Carolina State Univ., Raleigh. Triangle Universities Nuclear Lab., Durham, N. C.). Nucl. Phys.; A144: 539-44(1970).

The empirical Coulomb-energy differences of single-particle states are plotted for $T_z = \pm 1/2$ mirror nuclei having mass numbers $A = 4n + 1$. At A = 29, they decrease systematically in the order $1d_{5/2}$, $2s_{1/2}$, $1f_{7/2}$, $2p_{3/2}$ and $2p_{1/2}$. With appropriate omissions, the same sequence is observed at the higher mass numbers A = 33, 37 and 41. Except for the inversion of the $2s_{1/2}$ and $1d_{3/2}$ states at A = 29, the pattern is very similar to the one in the neutron separation energies S_n of the same states. The latter represent the nuclear interaction of the odd nucleon with the core, which is compared with the Coulomb interaction of the odd proton with the core. At least for A = 13 and 17, the $2s_{1/2}$ states have a relatively low Coulomb-energy difference. Another exception occurs for the $1d_{5/2}$ and $1f_{7/2}$ single-particle levels at A = 17, which have a relatively large Coulomb-energy difference that is close to the one of the $1d_{5/2}$ ground state. (auth)

38329 NUCLEAR ENERGY-GAP CALCULATIONS USING REALISTIC AND DELTA-FUNCTION FORCES. Jain, M. C.; Waghmare, Y. R. (Indian Inst. of Tech., Kanpur, India). J. Phys., A (London); 3: 274-9(May 1970).

Energy gap calculations were made with the realistic Yale–Shakin (1962 and 1966) interaction and the standard δ-function interaction. States below the valence shell were taken into account. It was found that the results were very close, showing that they were partially insensitive to the details of the interaction. The constant-Δ approximation was found to be very well justified. (auth)(UK)

38330 APPLICATION OF EIGENCHANNEL THEORY TO COULOMB EXCITATION OF ATOMIC NUCLEI. Greiner, Bernd (Technische Hochschule, Darmstadt, Ger.). Z. Naturforsch.; 25a: 170-81(Feb 1970). (In German).

The eigenchannel method is applied to Coulomb excitation. The formalism is developed and the involved matrix elements are calculated analytically. Estimates for the density of internal states are given. This method should prove fruitful for the calculation of quantum mechanical corrections of the semi-classical treatment of Coulomb excitation. (auth)

38331 RESONANCE EFFECTS IN NUCLEAR REACTIONS: GIANT RESONANCES IN THE TOTAL CROSS SECTION. Strzalkowski, Adam (Inst. of Nuclear Physics, Krakow). Postepy Fiz.; 21: 53-68(1970). (In Polish).

The nature of the giant resonances in the total cross section is discussed. It is shown that such resonances could be explained as a superposition of interference maxima corresponding in the semi-classical picture to the nuclear Ramsauer effect. (auth)

38332 OPTICAL-POTENTIAL DEPTH FROM MANY-BODY THEORY. Azziz, N. (Westinghouse Atomic Power Div., Pittsburgh). Nucl. Phys.; A147: 401-22(1970).

The optical-potential depth V_0, as a function of the energy E of the incoming neutron (proton) and the number of protons and neutrons in the target nucleus, has been determined using a previously explained approach to the nuclear matter theory. The resultant expression is $V_0 = -48.6 + 0.30\,(E - \overline{V}_c) \pm 30\,(N - Z)/A$ MeV. If the incoming particle is a neutron, the + sign is used and $\overline{V}_c = 0$, whereas if it is a proton, the – sign is used and $\overline{V}_c$ represents an average Coulomb potential for the incoming proton. The same approach predicts a value of 29 MeV for the symmetry coefficient of the term $(N - Z)^2/A$ of the Weizsäcker mass formula. Comparisons with semi-empirical formulas give satisfactory confirmation of the results. (auth)

38333 TRANSLATIONALLY INVARIANT SHELL MODEL. Kurdyumov, I. V.; Smirnov, Yu. F.; Shitikova, K. V.; El-Samarai, S. Kh. (Moscow State Univ.). Nucl. Phys.; A145: 593-612 (1970).

The translationally invariant shell model in which the nucleons oscillate harmonically with respect to the nuclear center of mass is considered. In this model the wave function of the nucleus depends on the 3(A – 1) Jacobi coordinates. Thus, the problem of the spurious states is absent in this model. The transformation from one set of Jacobi coordinates into another for the oscillator wave functions is discussed. The method for calculating the fractional parentage coefficients is set out. (auth)

38334 EFFECT OF THE FINAL STAGE OF FISSION PROCESS ON DISTRIBUTION OF FRAGMENT MASS AND CHARGE DISTRIBUTION. Karamyan, S. A.; Oganesyan, Yu. Ts.; Pustyl'nik, B. I. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 11: 982-91(May 1970). (In Russian).

Fission of excited nuclei produced in reactions with heavy ions is considered. Validity of various nuclear fission models to describe the fragment mass and charge distributions is analyzed. It is shown that without an account of the effect of the final stage of the fission process on the fragment mass and charge dispersion one does not succeed in getting a satisfactory agreement between theory and experiment. Magnitudes are estimated of the additional dispersions of the fragment mass and charge distribution, $[\sigma_A^f]^2$ and $[\sigma_Z^f]^2$ due to the finite size of the neck connecting the fragments before the separation. (auth)

38335 K X-RAY ISOTOPE SHIFTS. Seltzer, E. C. (California Inst. of Tech., Pasadena). Phys. Rev.; 188: 1916-19 (20 Dec 1969).

Numerical data are presented for the analysis of K x-ray isotope shift experiments for $30 \leq Z \leq 103$. The isotope shift is expressed in terms of the change in the even moments of the nuclear charge. Additional contributions to the isotope shift are briefly discussed. (auth)

38336 QUADRUPOLE EXCITATIONS OF EVEN–EVEN NUCLEI IN INELASTIC SCATTERING. Gonchar, V. Yu.; Yushkov, A. V. (Inst. of Nuclear Physics, Alma-Ata, USSR). Yadern. Fiz.; 11: 1034-6(May 1970). (In Russian).

Nuclear matrix elements $C_1(2)$ are calculated from experiments on 40 MeV α-particle inelastic scattering for a wide range of nuclei from ^{58}Ni up to ^{176}Yb. $C_1(2)$ are interpreted on the basis of the superfluid nuclear model. The calculations are performed on the BESM-4 computer using a special program with account of the pair correlations and the quadrupole–quadrupole nucleon interaction in nonoccupied shells. The contribution from the nuclear core was taken into account by means of effective neutron and proton charges. Functional correlation of theoretical and experimental values of $C_1(2)$ depending on the atomic weight is found. (auth)

38337 EFFECT OF STRUCTURE OF ONE-PARTICLE SPECTRUM ON LEVEL DENSITY IN NUCLEI OF RARE-EARTH ELEMENTS. Rubchenya, V. A. Yadern. Fiz.; 11: 1028-33(May 1970). (In Russian).

Density of highly excited levels in nuclei of rare-earth elements is calculated in the superfluid model and in the model of noninteracting particles using the one-particle spectrum of Nilsson's model. Comparison with the experimental data for even–even nuclei shows that results of the calculations are in reasonable agreement with experiment if contribution from collective states is taken into account. It is noted that the discrete structure of the one-particle spectrum and the pair correlations invalidate the conventional simple state equation of the Fermi gas $U = aT^2 + P$ with phenomenological account of the pair effects. (auth)

38338 PECULIARITIES OF THE TWO-NUCLEON TRANSFER REACTIONS. Lkhagva, O.; Rotter, I. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 11: 1037-43 (May 1970). (In Russian).

Some structure peculiarities of the heavy ion two-nucleon transfer reactions are considered. The effect of the intermediate states of the transferred nucleons on the excitation spectrum of the final nucleus is discussed. (auth)

38339 STRUCTURE OF MATRIX ELEMENTS OF NUCLEON PAIR INTERACTION IN NUCLEI. Rudak, E. A. (Inst. of Physics, Minsk). Yadern. Fiz.; 11: 1024-7(May 1970). (In Russian).

The dependence of the pair diagonal nonsymmetrized matrix elements of the nucleon pair interaction in nuclei on the resulting spin I is investigated. The matrix elements of the Wigner, spin-exchange, and tensor forces are represented as an expansion in powers of I(I + 1). (auth)

38340 APPLICATION OF THE BATEMAN METHOD FOR FACTORIZATION OF TWO-PARTICLE AMPLITUDE IN THREE-BODY PROBLEM. Akhmadkhodzhaev, B.; Belyaev, V. B.; Vzhetsionko, E. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 11: 1016-23(May 1970). (In Russian).

Approximate solution of the Lippman–Schwinger equation in the three-body problem is given. The t matrix is obtained as a sum of factorized terms. Using such a matrix, the Faddeev equations for the problem of the three nucleon bound states are solved. The calculation was performed with realistic nucleon–nucleon potentials describing the $^3S_1$ and $^1S_0$ phase shifts in the energy region up to 400 MeV. (auth)

38341 DENSITY OF LEVELS IN NEAR-MAGIC NUCLEI. Ignatyuk, A. V.; Stavinskii, V. S.; Shubin, Yu. N. (Physico-Energetics Inst., Moscow). Yadern. Fiz.; 11: 1012-15(May 1970). (In Russian).

Results of calculations of thermodynamical functions and density of levels in nuclei with magic neutron and proton numbers are presented. The calculations show that the constant temperature approach, supported by experiments on such nuclei, is a result of the discrete shell structure of the one-particle state spectrum. (auth)

38342 STRUCTURE OF FINITE NUCLEI IN THE LOCAL-DENSITY APPROXIMATION. Negele, J. W. (Cornell Univ., Ithaca, N. Y.). Phys. Rev., C; 1: 1260-1321(Apr 1970).

A new theory is presented for calculating the structure of finite nuclei from the nucleon–nucleon interaction. The essential features of the reaction matrix in finite nuclei are obtained from nuclear-matter theory through the local-density approximation. The resulting density- and energy-dependent effective interaction is justified in detail, and it is shown that the tensor force plays an important role in saturation. The effective interaction is cast into two different forms, one convenient for use in calculating matrix elements and the other specialized for a Hartree–Fock calculation in position space. The density-dependent Hartree–Fock equations are derived by variation of the ground-state expectation value of the energy, and in addition to the usual Hartree–Fock terms, one obtains rearrangement terms arising from the variation of the density appearing in the density-dependent interaction. The appropriate angular-momentum reduction for closed j-shell nuclei is performed. The need for modifying the effective interaction to account for higher-order corrections is discussed, and the constraints imposed on this modification by the properties of nuclear matter are examined. The results of this theory for ^{16}O, ^{40}Ca, ^{48}Ca, ^{90}Zr, and ^{208}Pb are shown to yield very satisfactory agreement with experimental binding energies, single-particle energies, and electron scattering cross sections. The rearrangement terms in the density-dependent theory are demonstrated to have two essential effects on nuclear structure: a significant reduction in the central density of the nucleus, and a modification of the usual Hartree–Fock relation between single-particle energies and the binding energy. Equivalent local single-particle potentials are calculated and are shown to have significant state dependence. (auth)

38343 CONTRIBUTION OF DEUTERON BREAKUP CHANNELS TO DEUTERON STRIPPING AND ELASTIC SCATTERING. Johnson, R. C. (Univ. of Surrey, Eng.); Soper, P. J. R. Phys. Rev., C; 1: 976-90(Mar 1970).

A model of deuteron stripping and elastic scattering which treats explicitly the contributions from channels in which the deuteron is broken up into a relative S state and the target is in its ground state is presented. An adiabatic treatment of these channels leads to a description of deuteron stripping which resembles the distorted-wave Born approximation, although a deuteron optical potential plays no role. The adiabatic approximation is shown to give a good account of 21.6-MeV elastic deuteron scattering from Ni, at least for surface partial waves, and is expected to apply to other nuclei in this mass and energy region, as well as at higher energies. The calculations assume that the effective two-nucleon–nucleus interaction is the sum of the nucleon optical potentials evaluated at one-half the incident deuteron kinetic energy. Some possible corrections to this assumption are discussed. (auth)

38344 NUCLEAR GIANT QUADRUPOLE RESONANCES IN SPHERICAL EVEN-EVEN NUCLEI. Urbas, Tadas D.; Greiner, Walter (Univ., Frankfurt am Main). Phys. Rev. Lett.; 24: 1026-8(4 May 1970).

The dynamic collective model is extended to quadrupole giant resonances in spherical nuclei. The splitting of giant dipole and giant quadrupole resonances due to their coupling to surface vibrations is calculated for Sn isotopes. Agreement with recent γ-absorption measurements of the Livermore group is found. (auth)

38345 ANALYTICAL APPROXIMATION OF THE COMBINATORIAL CALCULATION OF NUCLEAR LEVEL DENSITIES. Gilat, Jacob (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., C; 1: 1432-45(Apr 1970).

An exact numerical solution of the spin-dependent level-density problem for a spherical shell-model nucleus with realistic single-particle level spacings is used to investigate the validity of analytical expressions based on approximate treatments of the model. With parameters chosen by reference to the numerical values, at least one of the analytical expressions proposed in the literature results in adequate fits to these values. Fitted parameters for the region Z = 25 to 59 and N = 25 to 91 are presented, and their physical interpretation is discussed. The dependence of the parameters on the number of nucleons of either kind is strongly affected by the shell structure of the nucleus. The level-density parameter a is not simply proportional to the mass number A, and the spin distribution parameter can not be represented by the rigid-body moment of inertia, nor by any other monotonic function of A. Both parameters vary smoothly across the major proton and neutron shells, and the contributions of the two types of nucleons are additive. (auth)

38346 ANALYSIS OF PROTON ELASTIC SCATTERING USING POTENTIALS DERIVED FROM NUCLEON-DENSITY DISTRIBUTIONS AND TWO-BODY POTENTIALS. Greenlees, G. W.; Makofske, W.; Pyle, G. J. (Univ. of Minnesota, Minneapolis). Phys. Rev., C; 1: 1145-56(Apr 1970).

Proton elastic scattering data at 30.3 MeV are analyzed using the optical model recently developed by Greenlees, Pyle, and Tang. The present analysis differs from that given in the original paper in using a model-exact treatment of the spin-orbit and isospin terms of the potential. The quality of the fits obtained is insensitive to the detailed manner in which the potential is constructed and, in particular, to the choice of nucleon–nucleon force parameters. These parameters are therefore taken from an analysis of low-energy nucleon–nucleon scattering data, thus enabling the present analysis to give nuclear-neutron rms radii. The n-p rms-radius difference is about zero for medium-weight elements and 0.1–0.2 F for heavy elements. Evidence is presented supporting the conclusion that the volume integral and the rms radius of the real central potential are the well-defined quantities which can be deduced from analyses of elastic proton scattering data. (auth)

38347 WHY THE HIGH-ENERGY OPTICAL POTENTIAL CAN BE AND SHOULD BE CONSIDERED LOCAL. Reading, J. F. (Northeastern Univ., Boston). Phys. Rev., C; 1: 936-7(Mar 1970).

The approximate treatment of the nonlocality of the optical potential describing scattering from a set of N nonoverlapping potentials is shown to lead to erroneous effective local potentials. The difficulty is circumvented by constructing a local two-body t matrix which leads directly to a local potential. (auth)

38348 EFFECT OF RESIDUAL INTERACTIONS ON COULOMB ENERGY SHIFTS IN ANALOGUE STATES. Auerbach, E. H.; Kahana, S.; Scott, C. K.; Weneser, J. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev.; 188: 1747-52(20 Dec 1969).

The effect of residual interactions on the Coulomb energy separation between analog states is examined in the same spirit and accuracy with which residual interactions are handled in nuclear physics. A closed-form expression allows for simple calculational procedures. The dependence on the form of the residual interaction can then be easily explored. A specific calculation is made for the Ca isotopes; the effect of configuration mixing is studied. (auth)

38349 CLASSIFICATION OF THE EXCITED STATES IN LIGHT NUCLEI. III. THE TWO-EXCITED OSCILLATOR-STATES FOR p-NUCLEI. Sabalyauskas, L. Yu. (Inst. of Physics and Mathematics, Vilnyus, USSR). Liet. Fiz. Rinkinys, Liet. TSR Mokslu Akad., Liet. TSR Aukst. Mokyklos; 9: 477-86 (1969). (In Russian).

The features of the classification of the two-excited oscillator states for p-nuclei in the scheme of unitary symmetry are discussed. The full classification of the states for all p-nuclei with the number of quanta by two more than that in the ground state is presented. (auth)

38350 INTRANUCLEAR-CASCADE CALCULATION OF THE SECONDARY NUCLEON SPECTRA FROM NUCLEON–NUCLEUS INTERACTIONS IN THE ENERGY RANGE 340 TO 2900 MeV AND COMPARISONS WITH EXPERIMENT. Bertini, Hugo W. (Oak Ridge National Lab., Tenn.). Phys. Rev.; 188: 1711-30(20 Dec 1969).

Total nonelastic cross sections and the nucleon spectra from continuum-state transitions for protons on complex nuclei are calculated using the intranuclear-cascade approach. Comparisons with experiment are made over the energy range 340 to 2900 MeV. The diffuseness of the nuclear surface, the energy distribution of the bound nucleons, and the exclusion principle are taken into account in the model of the nucleus, while experimentally determined free-particle elastic, inelastic, and differential cross sections are utilized in the calculation of the particle–particle reactions assumed to take place inside the nucleus. The Sternheimer–Lindenbaum isobar model is used in describing all pion-production processes. All but two of the comparisons with experiment are made on an absolute basis. The theoretical nonelastic cross sections and the theoretical secondary-particle spectra resulting from continuum-state transitions are shown to be in reasonable agreement with experimental data over the broad energy range considered. The effect of pion production and the effect of the diffuse nuclear boundary are illustrated for a few cases. The quasifree peak is shown to be dominated by single-scattering events that take place inside the nucleus. (auth)

38351 SELF-CONSISTENT OCCUPATION PROBABILITIES IN BRUECKNER–HARTREE–FOCK CALCULATIONS. McCarthy, R. J. (Carnegie-Mellon Univ., Pittsburgh); Davies, K. T. R. Phys. Rev., C; 1: 1644-7(May 1970).

A method is developed for evaluating self-consistent occupation probabilities in Brueckner–Hartree–Fock calculations of finite nuclei. The method does not involve explicitly the overlaps of defect wave functions but is based instead on the energy dependence of the G matrix elements. Results are presented for ^{16}O using a G matrix which shifts only the low-lying intermediate-particle spectrum. (auth)

38352 ANALYSIS OF THE DISTRIBUTION OF THE SPACINGS BETWEEN NUCLEAR ENERGY LEVELS. Monahan, James E.; Rosenzweig, Norbert (Argonne National Lab., Ill.). Phys. Rev., C; 1: 1714-23(May 1970).

An empirical spacing distribution is always based on a finite, and usually small, number of observed levels. Thus, even if the spacing of levels were described exactly by the random-matrix model, the observed distribution would necessarily fluctuate about the theoretical mean–the Gaudin–Mehta distribution. A statistic $\Lambda(n)$ is defined to enable one to judge whether the magnitude of the observed fluctuations about the Gaudin–Mehta distribution is compatible with the random-matrix model. It is found that the correlations between the spacings implied by the model tend to reduce the expected fluctuations significantly. The statistical properties of $\Lambda(n)$ are studied by means of a Monte Carlo calculation with matrices of order 100 sampled from the Gaussian orthogonal ensemble. An illustrative analysis of the published neutron resonances observed in ^{239}U by Garg et al. reveals no obvious discrepancy between theory and experiment up to neutron kinetic energies of about 2 keV. (auth)

38353 NUCLEAR OPTICAL MODEL CALCULATIONS. I. Sakakibara, Shyoji. Chubu Kogyo Daigaku Kyo; 5: 185-9(Dec 1969). (In Japanese).

An optical model code for calculation of the differential elastic scattering cross section and polarization was programmed. As a test calculation of this code, firstly, a Gaussian absorption potential was used for a neutron elastic scattering cross section calculation and, secondly, Percy's equivalent non-local potential was used. In each case, good agreements with experimental data were obtained. This program was coded for the FACOM 270-30 computer at Chubu Institute of Technology, and the running time for a set of parameters with spin-orbit coupling is about 3 minutes. (auth)

38354 INTERNAL BREMSSTRAHLUNG RESULTING FROM THE PERTURBING ACTION OF ELECTROMAGNETIC INTERACTION IN WEAK INTERACTIONS AND IN THE β DECAY OF NUCLEI. Hock, Gabor. ATOMKI (At. Kut. Intez.) Kozlem.; 11: 111-17(Nov 1969). (In Hungarian).

The internal bremsstrahlung in radioactive α decay may be described by the field theory, taking the presence of nuclei into account. This approach was used as the basis to examine the effect of electromagnetic radiation observed in weak interactions, considering also the mechanism which generates this radiation. The current–current theory of weak interactions served as the basis of the generalization because it provides a unified explanation for the internal bremsstrahlung observed in the β decay of radioactive nuclei, the electromagnetic radiation which occurs in pure leptonic and nonleptonic processes and the weak decay of strange particles. Examination of the nature of radiative weak interactions revealed that the perturbing effects of the electromagnetic interaction may also occur whenever there are particles possessing a charge or magnetic moment, thus also in strong interactions. (TTT)

38355 NUCLEAR SCATTERING IN THE TWO-PARTICLE RPA. Hahne, F. J. W.; Dover, Carl B. (Univ., Heidelberg). Nucl. Phys.; A145: 378-86(1970).

The two-particle random-phase approximation (RPA), frequently used to describe pairing modes in bound state problems, is extended to include configurations with one particle in the continuum. The scattering of a nucleon from a target nucleus consisting of a correlated doubly closed shell core plus one particle is considered, and the S-matrix for this process is derived. The analytic properties of the particle-particle RPA are compared to those previously obtained for the particle-hole case. (auth)

38356 FINAL-STATE INTERACTIONS IN QUASIFREE ELECTRON SCATTERING FROM NUCLEI. Epp, C. D.; Griffy, T. A. (Univ. of Texas, Austin). Phys. Rev., C; 1: 1633-9(May 1970).

The effect of strong final-state interactions on the process A(e,e'p)B is investigated. Cross sections for this process are calculated for various bound-state proton wave functions, and an optical-model potential is used to describe the final-state interaction. (auth)

38357 BRUECKNER–HARTREE–FOCK CALCULATIONS OF SPHERICAL NUCLEI IN A HARMONIC-OSCILLATOR BASIS. II. Davies, K. T. R. (Oak Ridge National Lab., Tenn.); Baranger, M. Phys. Rev., C; 1: 1640-4(May 1970).

An approximation made in previous Brueckner-Hartree-Fock calculations is removed. Both the hole-hole and the particle-hole matrix elements of the single-nucleon potential are now calculated with the correct available energy of the pair. It is shown that, with a given G matrix, the occupied states and energies do not depend on the prescription used for the particle-particle elements. The formalism is easily extended to include Brandow's occupation probabilities. (auth)

38358 CUSPS, THRESHOLD STATES, AND ^{16}N. Bonner, T. I. (Univ. of Wisconsin, Madison). Phys. Rev., C; 1: 1710-13(May 1970).

States of ^{16}N were observed whose excitation energies appear to be correlated with thresholds for neutron emission to excited states of ^{15}N. It is pointed out that similar correlations occur in ^{11}B and ^{12}C, and the correlation is discussed in terms of known threshold effects. (auth)

38359 INCLUSION OF NUCLEAR-STRUCTURE CALCULATIONS IN NUCLEON–NUCLEUS SCATTERING. Weigel, Manfred (Univ. of California, Berkeley). Phys. Rev., C; 1: 1647-50(May 1970).

It is shown how one can use the results of a nuclear-structure calculation in the theory of nucleon-nucleus scattering. The calculation is restricted to the simple case of nucleon scattering on a hole nucleus. The correlations of the ground state are included. (auth)

38360 HYDRODYNAMICAL MODEL OF THE NUCLEUS WITH SURFACE EFFECTS. Brennan, J. G. (Catholic Univ. of America, Washington, D. C. Naval Ordnance Lab., Silver Spring, Md.); Wernitz, C. Phys. Rev., C; 1: 1679-85(May 1970).

An attempt is made to improve the predictions of the A dependence of giant dipole energies of the two-fluid hydrodynamical models by the introduction of a more realistic surface behavior of the ground-state densities. The Euler-Lagrange equations of motion for the dipole oscillation are obtained by the expansion of the energy functional $\epsilon[\rho, (\vec{\nabla}\rho)^2, \alpha(\vec{r})]$, where minimization yields acceptable neutron and proton densities, in quadratic powers of the densities and their derivatives. The equations are solved under certain limiting conditions, but within these limitations a much better A dependence is obtained. (auth)

38361 CONVENIENT EXPANSION FOR LOCAL POTENTIALS. Harms, Edward (Rensselaer Polytechnic Inst., Troy, N. Y.). Phys. Rev., C; 1: 1667-79(May 1970).

A new separable expansion for local potentials is introduced. The expansion, called the unitary pole expansion, has real, energy-independent form factors, and satisfies the requirements of two-particle unitarity in all orders. The convergence of the expansion is investigated by comparing expanded and exact T matrices for negative energies, and by performing three-body bound-state calculations. In the latter case, a one-term approximation gives en-

ergies accurate to within 2% for potentials containing repulsion of the magnitude indicated by two-nucleon data. (auth)

38362 DIRECT NUCLEAR REACTIONS LEADING TO UNBOUND RESIDUAL NUCLEI. Noble, J. V. (Univ. of Pennsylvania, Philadelphia). Phys. Rev., C; 1: 1742-4(May 1970).

The distorted-wave matrix element for direct reactions leading to three-body final states is written in terms of convergent integrals. The resulting expression can be evaluated in the Butler approximation, which leads to a diffractive model of the competition of, and interference between, direct breakup and sequential decay reaction mechanisms. Using Amado's methods, the general presence of such interference in processes of interest is demonstrated. Moreover, it should be possible to normalize unstable-state spectroscopic factors by measuring this interference. (auth)

38363 QUASI-ELASTIC ELECTRON SCATTERING FROM A FINITE-TEMPERATURE NUCLEUS. Freiberg, D. H. (Sanford Univ., Calif.). Phys. Rev., C; 1: 1735-9(May 1970).

An analytic formula is derived for quasi-elastic electron scattering from a compound nucleus. The nucleus is treated as a finite-temperature Fermi gas, although the formula can be used for any nuclear momentum distribution. Many-body correlations can be included by the use of an effective nucleon mass. The formula is good in the high-energy (several BeV) region, and can be used for estimating background. The Drell-Walecka form factors are calculated assuming the finite-temperature Fermi gas distribution. (auth)

38364 THEORIES OF ISOBARIC ANALOG RESONANCES. Weidenmueller, Hans A. (Univ., Heidelberg. Max-Planck-Institut fuer Kernphysik, Heidelberg). Phys. Rev., C; 1: 1875-7(May 1970).

The differences between various microscopic theories of isobaric analog resonances are exhibited. It is shown that the physical assumptions underlying the recent theory of Zaidi and Dyer are identical to those used in the formulation of Mekjian and MacDonald. (auth)

38365 ON THE RELATION BETWEEN THE DOUBLE-PROJECTION METHOD OF PEIERLS AND THOULESS, AND THE VILLARS THEORY OF THE NUCLEAR COLLECTIVE ROTATION. da Providencia, J.; Urbano, J. N. (Univ., Coimbra, Portugal). Nucl. Phys.; A145: 28-32(1970).

In order to investigate the relation between the Peierls-Thouless and the Villars method a new type of operator (namely the $Q_0(a)$) is introduced. Although the limit of $Q_0(a)$ as a tends to 1 is a particular form of the double-projection operator of Peierls and Thouless, the limit as a tends to 1 of the Hamiltonian expectation values taken with the new operator are essentially different from the Hamiltonian expectation values taken with the Peierls-Thouless projector ($\lim_{a \to 1} E(a) \neq E(a = 1)$). Actually it is shown that the former are equal to both: (i) expectation values of the Villars intrinsic Hamiltonian taken with nonprojected wave functions, and (ii) properly weighted averages of Hamiltonian expectation values taken with particular double-projected wave functions of Peierls and Thouless. (auth)

38366 LOW-LYING OCTUPOLE STATES OF THE DOUBLY EVEN DEFORMED NUCLEI WITH $152 \leq A \leq 190$. Neergard, K.; Vogel, P. (Univ. of Copenhagen). Nucl. Phys.; A145: 33-80(1970).

The low-lying octupole states of the doubly even deformed nuclei with $152 \leq A \leq 190$ are studied. The pairing + a modified octupole-octupole force is utilized as residual interaction. The ordering of states with different K-quantum numbers is analyzed in terms of the shell-model orbits filled. The problem of admixtures of the c.m. motion into the octupole states is investigated. The quasiparticle random phase approximation (RPA) equations are solved and in each nucleus the lowest $K^\pi = 0^-, 1^-, 2^-, 3^-$ states are obtained. Then, the Coriolis interaction matrix elements between states with K and K + 1 are calculated and the corresponding matrix is diagonalized. The resulting energies and B(E3) values are compared with the experimental data. The agreement is surprisingly good. It turns out that the inclusion of the Coriolis coupling is very essential for the explanation of the B(E3) values and the energy intervals within the rotational bands. The modification of the octupole-octupole force makes it possible to use interaction constants practically independent of the K-value. (auth)

38367 FIRST 2^+ AND 3^- STATES OF SPHERICAL NUCLEI. Birbrair, B. L.; Erokhina, K. I.; Lemberg, I. Kh. (Ioff Physico-Technical Inst., Leningrad). Nucl. Phys.; A145: 129-42(1970).

The energies EJ and reduced transition probabilities B(EJ) of first 2^+ and 3^- excited states of spherical nuclei are calculated within the framework of Migdal's method including both particle-hole and particle-particle interactions. The numerical calculations show that the first 2^+ states are not pure quadrupole phonons since the particle-particle interaction generates a rather strong 2^+ state pairing vibration component. The first 2^+ states of single closed-shell (SCS) nuclei are 2^+ state pairing vibrations rather than quadrupole phonons. At the same time the first 2^+ states of doubly unmagic nuclei are a mixture of quadrupole phonon and pairing vibration components. This naturally explains why the B(E2) values in SCS nuclei are much less than those in doubly unmagic ones. The first 3^- states are pure octupole phonons since the particle-particle interaction is found to be ineffective in this case. (auth)

38368 COORDINATE-SPACE STUDY OF NUCLEAR SELF-CONSISTENT FIELDS. II. NUMERICAL APPLICATIONS. Stingl, M. (Weizmann Inst. of Science, Rehovot, Israel); Sauer, P. U.; Faessler, Amand; Wolter, H. H. Nucl. Phys.; A145: 177-202(1970).

Results are presented on the generalized potential functions and Hilbert-Schmidt operator norms suggested in a previous article for the coordinate-space description of nuclear self-consistent potentials. After a review of the basic assumptions on the two-nucleon potential and on the self-consistent density matrices, the calculation of the coordinate-space quantities is discussed in detail. It is emphasized that these quantities can be obtained accurately even with a limited single-particle basis if a closed analytic expression for the two-nucleon force is given. The spin, isospin and space-multipole analysis of a general nonlocal potential, as well as a translation formula for generalized multipole fields suitable for the calculation of generalized potential functions, are presented in appendices. Numerical results for 2s-1d shell nuclei and the Ca isotopes are discussed, including nonlocality distributions and lengths, second-order nonlocality corrections, and Hartree-Bogoliubov pairing potentials. (auth)

38369 CORRELATED CHARGE FORM FACTORS FOR p-SHELL NUCLEI USING FINITE WELL WAVE FUNCTIONS. Sparrow, D. A.; Gerace, W. J. (Princeton Univ., N. J.). Nucl. Phys.; A145: 289-305(1970).

The effect of short-range correlations on electron scattering form factors for p-shell nuclei is calculated using realistic wave functions, and including the correlations between all states of relative motion. A technique is developed for accurately evaluating the radial integrals by expanding in harmonic oscillator states. The effects of correlations are found to increase in strength with increasing nucleon number, and are distinct from changes in well geometry. Inclusion of short-range correlations makes it possible to obtain a reasonable fit to the elastic electron scattering data using standard optical-model well geometries. This is in contrast to wells which are chosen to best fit the scattering data and which give a well radius much larger than the optical-model radius. Correlated and best-fit form factors differ primarily at large momentum transfer, displaying the importance of further high-energy electron scattering experiments. (auth)

38370 CONSISTENT TREATMENT OF EXCHANGE CURRENTS IN NUCLEI. Stichel, P. (Univ., Hamburg. DESY, Hamburg); Werner, E. Nucl. Phys.; A145: 257-81(1970).

A consistent treatment of two-particle exchange currents in nuclei in the framework of the one-boson-exchange-model for the nucleon-nucleon interaction is given. Relativistic effects are taken into account up to order $(P/M)^2$. The general formalism for the evaluation of matrix elements of two-body currents in many-nucleon systems is outlined. Possible applications to the two-nucleon system are briefly discussed. (auth)

38371 INTENSION OF THE SHELL MODEL WITH CONFIGURATION INTERACTIONS TO NUCLEAR REACTIONS. Hahn, Yukap (Univ. of Connecticut, Storrs). Nucl. Phys.; A146: 62-80(1970).

An extension of the shell model to nuclear reactions in which composite projectiles are involved is studied within a simple model system which contains an infinitely heavy inert core nucleus. The formal as well as practical difficulties of the continuum shell model for the nucleon-heavy nucleus scattering are removed by the modified basis functions which can readily incorporate strong long-range correlations. The deuteron-nucleus channel and its coupling to the stripping channels are discussed in detail. (auth)

38372 DERIVATION OF THE RADIAL DEPENDENCE OF THE QUADRUPOLE FORCE FROM A WOODS-SAXON POTENTIAL. Kumar, K. (Univ. of Copenhagen); Soerensen, B. Nucl. Phys.; A146: 1-14(1970).

For use in calculation of collective quadrupole phenomena a modified quadrupole force is constructed whose radial dependence

is related to that of a Woods–Saxon well. Matrix elements and self-consistent interaction strengths are compared to those of the usual quadrupole force, which is based on a harmonic oscillator potential. (auth)

38373 ANALYTICAL METHOD TO DESCRIBE ELECTRON INELASTIC SCATTERING ON NUCLEI WITH EXCITATION OF LOW LYING LEVELS. Luk'yanov, V. K.; Pol, Yu. S. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 11: 556-66(Mar 1970). (In Russian).

The method is developed to calculate the electron inelastic scattering on nuclei with the excitation of low-lying levels which can be described in terms of any (micro or macro) nuclear model. The method is to separate the radial part of nuclear transitional density and to represent it as a series of derivatives of the Fermi density. An explicit dependence of the scattering cross section on the expansion coefficients of transitional density allows one to analyze directly the experimental data to obtain information on the radial transitional nuclear density and on the value B(EL). The method is used to analyze the experimental data on the ^{58}Ni nucleus. (auth)

38374 INFLUENCE OF THE TEMPERATURE FLUCTUATIONS ON THE FORM OF THE EVAPORATED NEUTRON SPECTRUM. Stavinskii, V. S. Yadern. Fiz.; 11: 601-4(Mar 1970). (In Russian).

Anomalies in the form of the evaporated neutron spectrum are discussed in view of the fluctuations in the Gibbs canonical ensemble. (auth)

38375 DISPERSIVE EFFECTS IN ELASTIC ELECTRON SCATTERING BY VIBRATIONAL NUCLEI. Kujawski, E. (Univ. of Maryland, College Park). Contract GU2061. Phys. Lett.; 32B: 75-7(8 Jun 1970).

The effects of virtual nuclear excitations for elastic electron scattering by a quantized liquid drop are estimated with the second-order Born approximation. (auth)

38376 OPTICAL-MODEL ANALYSIS OF 28 AND 31 MeV PROTON ELASTIC SCATTERING. Sandhu, H. S. (San Fernando Valley State Coll., Northridge, Calif.). Nucl. Phys.: A146: 163-76(1970).

Optical model of the nucleus was used to obtain a theoretical representation of the differential cross section for elastic scattering of 31-MeV protons from C, N, O, ^{24}Mg, ^{26}Mg, Si, S, ^{60}Ni, ^{208}Pb, and ^{209}Bi. The analysis has also been extended to 28 MeV proton scattering data for C, Al, Si, Cu, Ag and Au. The values of average geometrical parameters ($r_0 = r_0' = r_c = 1.20$ fm, and $a = b = a_i = 0.70$ fm) have been found to give acceptable fits to all experimental data. In the subsequent analyses, the geometrical parameters were kept fixed in order to look for nuclear mass dependence of dynamical parameters. The mean-square matter radii have been determined and compared with the mean-square proton radii obtained from the electron-scattering data. (auth)

38377 S-MATRIX DESCRIPTION OF THRESHOLD EFFECTS IN (d,p) REACTIONS. Zimanyi, J.; Bondorf, J. P. (Univ. of Copenhagen). Nucl. Phys.; A146: 81-9(1970).

The S-matrix description of threshold phenomena is generalized to higher partial waves, and this method is applied to the interpretation of the charge-exchange threshold effect in the (d,p) reaction. (auth)

38378 LOW-LYING "ONE-PHONON" 0^+ LEVELS IN SPHERICAL NUCLEI. Kamerdzhiev, S. P. Yadern. Fiz.; 11: 537-44 (Mar 1970). (In Russian).

Consequences of exclusion of the zero energy "spurions" state in the total set of equations for the theory of finite Fermi-systems are discussed. Direct calculations show that spherical nuclei with the developed pairing must contain 0^+ levels with energy near 2Δ and with reduced probability of E0 transitions into the ground state $B(E0) < 1$ (in one-particle units). These levels cannot be referred to the known "two-phonon" 0^+ levels. The relative contribution of the effective particle-hole and particle-particle interaction responsible for the appearance of these levels is considered. (auth)

38379 TO THE THEORY OF ISOBARIC ANALOG RESONANCES. Kurlyandskii, A. S.; Urin, M. G. (Moscow Engineering-Physics Inst.). Yadern. Fiz.; 11: 545-55(Mar 1970). (In Russian).

The description of isobaric analog resonances in the region of non-overlapping levels of the compound nucleus is given. Formulas are obtained for the cross sections of (p,p') and (p,n) reactions with the account of two possible mixing mechanisms of analog and compound nuclear states. (auth)

38380 DIFFERENTIAL CROSS SECTIONS FOR QUADRANGULAR GRAPHS IN SOME DIRECT NUCLEAR REACTIONS. Magzumov, E. Zh.; Neudachin, V. G.; Belkin, M. S. (Inst. of Nuclear Physics, Moscow). Yadern. Fiz.; 11: 589-97(Mar 1970). (In Russian).

Results of calculation of differential cross sections of reactions (t,p) and (p,p') described by quadrangular graphs using distorted waves are given. The problem of the dependence of the cross section value on the energy of incident particles is studied. Absolute values of cross sections are also estimated based on the simple "oscillator" approximation by means of renormalizations of one-particle reduced widths calculated from the experimental data on reactions (d,p) and (t,d). (auth)

38381 RECENT RESULTS IN THE FIELD OF ELECTRON CAPTURE RESEARCH. Vatai, Endre (Nuclear Research Inst., Debrecen, Hungary). Fiz. Szemle; 20: 33-6(Feb 1970). (In Hungarian).

The phenomenon of electron capture lies at the boundary of nuclear and atomic physics. In the case of allowed transitions, the conditions of capture are independent of the nuclear structure and the information obtained refers primarily to the shell. Electron capture relations may also confirm the eigenfunctions of electrons at the surface of the nucleus. Electron rearrangements may also be studied by means of capture phenomena. Individual effects of electron capture may be noted by observing the residual electron deficiency in the shell on the basis of x-ray quanta and Auger electrons generated during the filling of these deficiencies. The electron wave functions, the Hartree–Fock approximation and the exchange correction problems are also reviewed. (TTT)

38382 INTERMEDIATE ENERGY NUCLEAR PHYSICS. Lock, W. O.; Measday, D. F. London; Methuen and Co. Ltd. (1970). 333p. 85s.

Among the subjects discussed are: some mathematical tools, pion interactions with nucleons, interactions of gamma-rays and electrons with nucleons, nucleon-nucleon elastic scattering, nucleon-nucleon inelastic reactions, interactions of leptons and photons with nuclei, interactions of nucleons with nuclei, interactions of pions with nuclei. (UK)

38383 NONLOCAL FORCES AND DIPOLE SUM RULES. Hammann, T. F.; Ho-Kim, Q. (Laval Univ., Quebec). Nuovo Cim.; 67A: 300-4(21 May 1970).

A realistic separable nucleon-nucleon interaction determined recently was applied to study the nonlocal effects of nuclear forces in the integrated photoabsorption cross section. Calculations performed in the electric-dipole approximation and with a Fermi gas nuclear model indicate a good agreement with experimental data in the heavy-nuclei region. (auth)

38384 SELF-CONSISTENT NUCLEAR SINGLE-PARTICLE HAMILTONIAN. Pandharipande, V. R.; Prasad, K. G. (Tata Inst. of Fundamental Research, Bombay). Nucl. Phys.; A147: 193-9(1970).

The Thomas–Fermi theory of nuclei was extensively used to define a single-particle Hamiltonian for nuclei. This Hamiltonian is solved self-consistently by a Hartree-type iterative procedure. The single-particle energies and the rearrangement effects are discussed. The results for ^{40}Ca are compared with those obtained with restricted Hartree–Fock calculations in harmonic oscillator approximation. (auth)

38385 A NEW ITERATIVE SOLUTION OF THE NUCLEAR THREE-BODY PROBLEM WITH GAUSSIAN POTENTIAL. Fabri, E. (Univ., Pisa, Italy. Istituto Nazionale di Fisica Nucleare, Pisa, Italy); Fiorio, G. Nucl. Phys.; A141: 25-36(1970).

The ground state of a three-body system with a spin-independent Gaussian potential is studied with the Chebyshev iteration method. With a relatively modest computational effort, better results are obtained than those published so far. (auth)

38386 METHOD FOR GENERAL SYSTEMATICS OF STABLE NUCLEI. Medi, E. Ass. Geofis. Ital., Atti Conv. Annu.; 16: 85-99(May 1967). (In Italian).

From 16th Annual Conference of Italian Geophysical Society, Naples, Italy. See CONF-670532.

A simple method of calculation by which it is possible to determine the number of protons and neutrons in stable nuclei, starting from the mass number is considered. This method does not consider nuclear structure theories. On the other hand it provides the possibility of a classification of stable nuclei. (auth)

38387 PERTURBATION THEORY FOR THE DEGENERATE CASE IN THE MANY-BODY PROBLEM. Oberlechner, G.; Owono-N'-Guema, F., Richert, J. (Centre de Recherches Nu-

cleaires, Strasbourg, France). Nuovo Cim.; 68B: 23-43(11 Jul 1970).

A time-dependent perturbation method which can be applied to the many-body problem in the degenerate case is developed. A clear correspondence between the diagrams given and their algebraic contribution is demonstrated and the secular equation leading to the resolution of the eigenvalue problem is derived. Further developments concerning expectation values of general operators are taken into account. The conclusions at every step of the discussion are found to be in full agreement with those given in an earlier publication by Brandow. (auth)

REACTOR TECHNOLOGY

Commercial Power Reactors

Refer also to abstracts 36163, 36647, and 36969.

38388 (CONF-700317) 1970 ELECTRIC UTILITY ENGINEERING CONFERENCE [EAST PITTSBURGH, PENNSYLVANIA], MARCH 15–MARCH 27, 1970. VOLUME III. NUCLEAR POWER. (Westinghouse Electric Corp., East Pittsburgh, Pa.). 159p. Westinghouse Electric Corp., East Pittsburgh, Pa. $4.00.

Topics related to the development of nuclear power plants in the U. S. are discussed. Separate abstracts are presented for 6 of the 7 papers included. One paper discusses water utilization in power production. (D.C.C.)

For abstracts of individual papers see: 38389, 38390, 38402–38404, and 38448.

38389 (CONF-700317, Paper 19) NUCLEAR FUEL CYCLE AND CORE MANAGEMENT. Leggett III, W. D. (Westinghouse Electric Corp., East Pittsburgh, Pa.). 17p.

From 1970 electric utility engineering conference, East Pittsburgh, Pa. Vol. III.

Fuel cycle costs and requirements for power reactors are analyzed. Core management procedures for optimum fuel utilization are described. (D.C.C.)

38390 (CONF-700317, Paper 20) LMFBR NUCLEAR POWER FOR 1980 AND BEYOND. Creagan, R. J.; Tower, S. N. (Westinghouse Electric Corp., East Pittsburgh, Pa.). 16p.

From 1970 electric utility engineering conference, East Pittsburgh, Pa. Vol. III.

Future power reactor development trends are discussed. Predictions for LMFBR development programs are presented. The Westinghouse LMFBR program is described. (D.C.C.)

38391 (EUR–4453) THE COMMUNITY'S URANIUM AND SEPARATIVE WORK REQUIREMENTS. Donato, M.; Pilion, Jacqueline (European Communities, Luxembourg. Commission). 6 Nov 1969. 36p. (In French). Dep. CFSTI (U. S. Sales Only). EUR FF 5,60.

A detailed analysis of the Community's long-term requirements for uranium and separative work units is presented. For the growth of reactor capacity, two models are taken into account, namely Model A, 100% LWR, and Model B, ⅔ LWR, ⅓ GGR. The target adopted is 60,000 MW(e) net installed nuclear capacity by 1980; allowance is made for the delays and losses involved in the various fuel cycle operations and for the recovery of the residual enriched uranium contained in irradiated fuels. Plutonium recycling is not taken into consideration. The economic importance of pinpointing delays and losses is described. Checking of this kind is particularly important and effective within the context of general concerted management of the fuel cycle. 6 references. (auth)

38392 (GAMD–10019) TENDON FABRICATION FOR PRESTRESSED CONCRETE REACTOR VESSEL AT FORT ST. VRAIN, COLORADO. Hildebrand, J. F. (Gulf General Atomic, Inc., San Diego, Calif.). 27 Apr 1970. Contract AT(04-3)-633. 231p. Dep. CFSTI.

The materials and procedures used to fabricate the 448 tendons plus one replacement tendon for the Fort St. Vrain reactor vessel are reviewed. The fabrication procedures, records of the wire properties, and lists of acceptance inspections of the stressing washers are included. (H.D.R.)

38393 (JUL–622-RG) EXPERIMENTS FOR A NEW CONTROL ROD CONCEPT FOR THE PEBBLE BED REACTOR. Hammelmann, K. H.; Hecker, R.; Galka, M.; Hellinger, H.; Tschakert, W.; Keintzel, G. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorentwicklung). Oct 1969. 112p. (In German). Dep. CFSTI (U. S. Sales Only).

The concept of the freely penetrating absorber rod was developed for the control and shut-down of the 300-MW(e) thorium high-temperature pebble-bed reactor. Scale models of this type of control rod were tested to determine the stresses on the rod and silo, the necessary moment of rotation, and the design requirements for the drive. The experimental data was also evaluated for the determination of the fuel rupture rate. (J.S.R.)

38394 (NEDO–10139) COMPLIANCE OF PROTECTION SYSTEMS TO INDUSTRY CRITERIA: GENERAL ELECTRIC BWR NUCLEAR STEAM SUPPLY SYSTEM. Hentschel, M. K.; Lane, M. R.; Scapini, D. G.; Stanley, L. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Jun 1970. 415p. (70-NED-43).

Illustrations of compliance of the GE BWR reactor protection system and core standby cooling systems with the requirements of the Institute of Electrical Electronics Engineers, "Proposed Criteria for Nuclear Power Plant Protection Systems (IEEE-279)," and justifications of any exceptions are presented. The presentation is based on a 1967 product line "A" size standard plant. Where the equipment design for other size standard plants differs in a significant way from the base plant, these variations are included in the discussion. In certain instances, reference is made to a particular power plant project, in order to develop specific implementation detail where it is expected that the same methods would be applied to the standard plant. The first section concentrates on the controls and instrumentation required for automatic, rapid insertion of control rods into the reactor core. A matrix table is used to demonstrate the physical, electrical and functional relationships of the reactor protection system with other systems and plant equipment. Also, a point-by-point comparison of the reactor protection system with IEEE-279 requirements is presented. The second section concentrates on the controls and instrumentation of the core standby cooling systems pertinent to the 1967 product line, also including a point-by-point comparison of its features with the "Proposed Criteria for Nuclear Power Plant Protection Systems (IEEE-279)." These core standby cooling systems are (1) core spray systems (CS), (2) high pressure coolant injection system (HPCI), (3) low pressure coolant injection system (LPCI), and (4) automatic depressurization system (ADS). The nuclear steam supply isolation system is also reviewed since automatic closure of certain nuclear steam supply isolation valves has an important protective function. A review of IEEE-279 is also included to provide some insight into observed difficulties in "interpretation" with the criteria document and also to offer suggestions for future improvements. Finally, a copy of IEEE-279 is included as an appendix. (auth)

38395 (STI/PUB–194/3) POWER AND RESEARCH REACTORS IN MEMBER STATES. May 1970 Edition. (International Atomic Energy Agency, Vienna (Austria)). 1970. 79p. IAEA $2.00.

A listing of worldwide power reactors and research reactors operating or being built is presented. Information provided includes: reactor type, reactor location, power output, and criticality date. (D.C.C.)

38396 ATOMNYE ELEKTRICHESKIE STANTSII. (Atomic Power Plants). Margulova, T. Kh. Moscow; Izdatel'stvo Vysshaya Shkola (1969). 384p.

The theory of thermal electric stations using nuclear fuel is discussed. The problems of conventional and atomic stations are considered. Diagrams of the energy requirements, condensers, evaporators, and turbine equipment are given. Designs are given for the physical plants, and the physical-chemical processes are discussed. Decontamination equipment and methods are described. The descriptions of atomic power plants with aqueous, gas, and liquid metal heat transfer systems are given for domestic and foreign systems. (tr-auth)

38397 PROBLEMS WITH THE MEASUREMENT AND CONTROL TECHNOLOGY EQUIPMENT FOR NUCLEAR POWER PLANTS. Merz, L. (Technische Hochschule, Munich). Atomwirt., Atomtech.; 15: 274–5(Jun 1970). (In German).

Problems encountered in the monitoring and control of nuclear power stations frequently are not caused by the instrumentation but by the planning concept. Three points are discussed as examples. In contrast to research reactors, power stations should not be controlled by neutron flux because such control leads to oscillations that damage control rods as well as fuel elements. This factor is especially significant for breeder reactors. Control system and safety system should be completely separated which is frequently not true in present German power stations. The containment vessel, including all instruments, should be tested periodically at high pressure. Often, instruments are constructed for normal operational pressures and will fail under sudden pressure increases as demonstrated by one incident in which several instruments in the reactor broke down because of an unexpected pressure increase. (H.B.G.)

38398 BEHAVIOR OF THE UPPER SLAB OF A PRESTRESSED CONCRETE VESSEL UNDER HIGH THERMAL STRESSES (BUGEY I). Gaveriaux, Carliez (Compagnie Industrielle de Travaux, Paris. Electricite de France, Clamart).

Ann. Inst. Tech. Batiment Trav. Publics; No. 266, 125-36(Feb 1970). (In French). (CONF-690344-2).

From 11th Meeting on Prestressed Structures, Paris.

The upper slab is circularly prestressed by horizontal prestressing flat sheet hoops. The instruments implanted inside (thermocouples and extensometers) are described. The upper slab is drilled with holes simulating the loading pits. The heat treatment of the slab comprises four steps: first, the slab was heated to the loading pits temperature; then, the loading pits temperature increased up to 80, 100 and 120°C. The results of the four tests performed are tabulated. Diagrams giving the evolution of temperatures and stresses in various points are plotted for the tests performed at 100°C. Then two calculations are computed: the effects of an instantaneous temperature increase (17°C) of the central zone on the structure and the effects of a linear temperature increase (17°C) made in transient state for two hours till stabilization. The outer stress graphs are plotted at various levels for a radial section. (auth) (France)

38399 MEMORY AND LOGIC CIRCUITS DEVELOPED AS PART OF AN OVERALL ADVANCED GAS COOLED REACTOR (AGR) POWER STATION CONTROL STUDY. Moleas, C. N. pp 229-34 of Analog and Hybrid Computation Applied to Nuclear Energy. Brussels, Presses Academiques Europeennes (1969).

From International Symposium on Analogue and Hybrid Computation Applied to Nuclear Energy, Versailles, France. See CONF-680941.

The details of two high speed logic and point memory circuits capable of being accommodated on the MLG facility of a PACE 231R-V computer are presented. The circuits were designed as part of a simulation suitable for studies of the proposed Hinkley Point B nuclear power station overall control scheme. The first circuit simulates the action of a direct digital control of reactor sector rod drive motors. The second represents an attempt to economize analog equipment by means of time-sharing a circuit normally reproduced at several points of a problem. The description of the two circuits is preceded by a brief outline of the overall problem of which they form a small part and the method adopted for its solution. Finally, experience of the simulation and specific points of interest are related. (auth)

38400 HYBRID COMPUTER OPTIMISATION OF A NUCLEAR POWER STATION CONTROL SYSTEM. Blake, R. G. (Central Electricity Generating Board, London); Pigott, P. M.; Smale, R. J.; Lotito, L. A. pp 264-9 of Analog and Hybrid Computation Applied to Nuclear Energy. Brussels, Presses Academiques Europeennes (1969).

From International Symposium on Analogue and Hybrid Computation Applied to Nuclear Energy, Versailles, France. See CONF-680941.

The hybrid computer simulation described was carried out: (1) to evaluate the role of hybrid computation in nuclear power station design; (2) to evaluate a particular Hybrid Computing System; and (3) to investigate the Dungeness B power station control scheme. The salient features of the Dungeness B simulation are briefly summarized. Most of the specific details of the work and the engineering results are passed over in favor of more general discussion of the basic approach to the problem. (auth)

Operation and Economics

38401 (CEA-R-4019) EFFECTS OF THE RATE OF THERMAL REACTORS CONSTRUCTION ON THE NUCLEAR PROGRAM STRUCTURE. Gaussens, Jacques; Paillot, Henri (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Jul 1970. 50p. (In French). Dep. CFSTI (U. S. Sales Only).

The massive implantation of nuclear power plants according to national programmes will require, over the next few years, the installation of a complete set-up fuel manufacturing and reprocessing plants as well as of power station equipment production facilities. The rate of installation of thermal and fast neutron reactors should only be determined taking into account the minimum load factor which could ensure the economic running of these plants. Methods are discussed for defining and optimizing the rate of thermal and fast neutron reactors and of the corresponding plants minimizing total discounted costs. (auth) (France)

38402 (CONF-700317, Paper 15) NUCLEAR POWER OVERVIEW. Farbman, G. H. (Westinghouse Electric Corp., East Pittsburgh, Pa.). 20p.

From 1970 electric utility engineering conference, East Pittsburgh, Pa. Vol. III.

A review of power reactor development in the U. S. is presented. Predictions for nuclear power plant growth in the U. S. are included. Westinghouse facilities are described. (D.C.C.)

38403 (CONF-700317, Paper 17) RELIABILITY AND OPERATING EXPERIENCE OF NUCLEAR POWER PLANTS. Goldsmith, E. A. (Westinghouse Electric Corp., East Pittsburgh, Pa.). 53p.

From 1970 electric utility engineering conference, East Pittsburgh, Pa. Vol. III.

Operations and maintenance requirements are reviewed for the following reactors: Yankee Power Reactor; Trino Power Reactor; SENA Power Reactor; Connecticut Yankee Power Reactor; San Onofre Power Reactor Unit 1; Zorita Power Reactor; Beznan Power Reactor Unit 1; and the Robert E. Ginna Power Reactor Unit 1. (D.C.C.)

38404 (CONF-700317, Paper 18) NUCLEAR POWER ECONOMIC STUDIES. Skooglund, J. W. (Westinghouse Electric Corp., East Pittsburgh, Pa.). 12p.

From 1970 electric utility engineering conference, East Pittsburgh, Pa. Vol. III.

Economic studies required for optimum power reactor design and application are described. Three topics concerning power plant economics are discussed. The failure of "mills/kWhr comparisons" to properly evaluate the relative economics of nuclear and fossil-fuel units is analyzed. An accurate technique for comparing the two power plant types is presented. The economic integration of nuclear and other power plant types is described. (D.C.C.)

38405 (CONF-700608-7) START UP OF NINE MILE POINT NUCLEAR STATION. Burt, P. A. (Niagara Mohawk Power Corp., Syracuse, N. Y.). [1970]. 25p.

From American Nuclear Society Meeting, Los Angeles, Calif.

The startup program for the Nine Mile Point Power Reactor is reviewed. Pre-operational testing, audit inspection, and AEC compliance requirements are described. Problem areas for the reactor are discussed under the following headings: electrical systems; instrument and process control; control rod drives; piping and valves; pumps; moisture removal; exciter reduction gear; and core spray piping cracks. Summaries are included for startup tests. (D.C.C.)

38406 (DOCKET-1151-32) ELK RIVER REACTOR. Monthly Report No. 22, April 1967. (NUS Corp., Washington, D. C.). 103p. (NUS-386). Dep. CFSTI.

For Rural Cooperative Power Association, Elk River, Minn.

38407 (DOCKET-1151-33) ELK RIVER REACTOR. Monthly Report No. 1, November-December 1964. (Nuclear Utility Services, Inc., Washington, D. C.). 22 Jan 1965. 54p. (NUS-214). Dep. CFSTI.

For Rural Cooperative Power Association, Elk River, Minn.

38408 (DOCKET-1151-34) ELK RIVER REACTOR. Monthly Report No. 21, March 1967. (NUS Corp., Washington, D. C.). 83p. (NUS-371). Dep. CFSTI.

For Rural Cooperative Power Association, Elk River, Minn.

38409 (DOCKET-1151-35) ELK RIVER REACTOR. Monthly Report No. 20, February 1967. (NUS Corp., Washington, D. C.). 35p. Dep. CFSTI.

For Rural Cooperative Power Association, Elk River, Minn.

38410 (DOCKET-1151-36) ELK RIVER REACTOR. Monthly Report No. 19, January 1967. (NUS Corp., Washington, D. C.). 57p. (NUS-342). Dep. CFSTI.

For Rural Cooperative Power Association, Elk River, Minn.

38411 (DOCKET-1155-41) LA CROSSE BOILING WATER REACTOR. Monthly Operating Report No. 11, May 1968. (Allis-Chalmers Mfg. Co., Bethesda, Md. Atomic Energy Div.). Contract AT(11-1)-850. 64p. (ACNP-68507). Dep. CFSTI.

38412 (DOCKET-1155-42) LA CROSSE BOILING WATER REACTOR. Monthly Operating Report No. 16, October 1968. (Allis-Chalmers Mfg. Co., Bethesda, Md. Atomic Energy Div.). Contract AT(11-1)-850. 17p. (ACNP-68515). Dep. CFSTI.

38413 (DOCKET-1155-43) LA CROSSE BOILING WATER REACTOR. Monthly Operating Report No. 15, September 1968. (Allis-Chalmers Mfg. Co., Bethesda, Md. Atomic Energy Div.). Contract AT(11-1)-850. 15p. (ACNP-68514). Dep. CFSTI.

38414 (DOCKET-1155-44) LA CROSSE BOILING WATER REACTOR. Monthly Operating Report No. 14, August 1968. (Allis-Chalmers Mfg. Co., Bethesda, Md. Atomic Energy Div.). Contract AT(11-1)-850. 20p. (ACNP-68512). Dep. CFSTI.

38415 (DOCKET-1155-45) LA CROSSE BOILING WATER REACTOR. Monthly Operating Report No. 13, July 1968. (Allis-Chalmers Mfg. Co., Bethesda, Md. Atomic Energy Div.). Contract AT(11-1)-850. 17p. (ACNP-68509). Dep. CFSTI.

38416 (DOCKET-1155-46) LA CROSSE BOILING WATER REACTOR. Monthly Operating Report No. 12, June 1968.

(Allis-Chalmers Mfg. Co., Bethesda, Md. Atomic Energy Div.). Contract AT(11-1)-850. 14p. (ACNP-68508). Dep. CFSTI.

38417 (DOCKET-1155-47) LA CROSSE BOILING WATER REACTOR. Monthly Operating Report No. 18, December 1968. (Allis-Chalmers Mfg. Co., Bethesda, Md. Atomic Energy Div.). Contract AT(11-1)-850. 60p. (ACNP-69500). Dep. CFSTI.

38418 (DOCKET-1155-48) LA CROSSE BOILING WATER REACTOR. Monthly Operating Report No. 10, April 1968. (Allis-Chalmers Mfg. Co., Bethesda, Md. Atomic Energy Div.). Contract AT(11-1)-850. 16p. (ACNP-68506). Dep. CFSTI.

38419 (DOCKET-1155-49) LA CROSSE BOILING WATER REACTOR. Monthly Operating Report No. 9, March 1968. (Allis-Chalmers Mfg. Co., Bethesda, Md. Atomic Energy Div.). 6 May 1968. Contract AT(11-1)-850. 29p. (ACNP-68504). Dep. CFSTI.

38420 (DOCKET-1155-50) LA CROSSE BOILING WATER REACTOR. Monthly Operating Report No. 8, February 1968. (Allis-Chalmers Mfg. Co., Bethesda, Md. Atomic Energy Div.). 8 Apr 1968. Contract AT(11-1)-850. 20p. (ACNP-68503). Dep. CFSTI.

38421 (DOCKET-1155-51) LA CROSSE BOILING WATER REACTOR. Monthly Operating Report No. 6, December 1967. (Allis-Chalmers Mfg. Co., Bethesda, Md. Atomic Energy Div.). 31 Jan 1968. Contract AT(11-1)-850. 20p. (ACNP-68500). Dep. CFSTI.

38422 (DOCKET-1155-52) LA CROSSE BOILING WATER REACTOR. Monthly Operating Report No. 7, January 1968. (Allis-Chalmers Mfg. Co., Bethesda, Md. Atomic Energy Div.). Contract AT(11-1)-850. 28p. (ACNP-68501). Dep. CFSTI.

38423 (DOCKET-1155-53) LA CROSSE BOILING WATER REACTOR. Monthly Operating Report No. 4, October 1967. (Allis-Chalmers Mfg. Co., Bethesda, Md. Atomic Energy Div.). Contract AT(11-1)-850. 17p. (ACNP-67534). Dep. CFSTI.

38424 (DOCKET-1155-54) LA CROSSE BOILING WATER REACTOR. Monthly Operating Report No. 5, November 1967. (Allis-Chalmers Mfg. Co., Bethesda, Md. Atomic Energy Div.). 8 Jan 1968. Contract AT(11-1)-850. 31p. (ACNP-67535). Dep. CFSTI.

38425 (DOCKET-50171-53) PEACH BOTTOM ATOMIC POWER STATION, UNIT 1. Monthly Operations Report No. 51, May 1970. (Philadelphia Electric Co., Pa.). 16 Jul 1970. 20p. Dep. CFSTI.

38426 (FN-E-74) PROGRESS REPORT NO. 1 ON THE INTEGRATED RESEARCH PROGRAM OF THE E. FERMI PLANT, SEMIANNUAL, JUNE-DECEMBER 1966. (FIAT, Turin (Italy). Sezione Energia Nucleare). 74p. (In Italian). Dep. CFSTI (U. S. Sales Only).

The validity of the calculation method for the reactivity balance is examined by comparing available experimental results and the theoretical analysis on neutron multiplication in critical configuration at the beginning of the first core cycle, temperature reactivity coefficient of the moderator, reactivity coefficient of the boron, and long-term reactivity variation. A representation of the core in (x,y) geometry compatible with the maximum capacity of the CONDOR-E code to be used in the analysis of the power distribution variation is selected. Power distributions at the beginning of the first cycle of the core are obtained. An analysis is made of the available experimental data on the power distribution of the core (Aeroball system). The useful power of the coolant crossing the various fuel cells is evaluated. A preliminary analysis is made of an incident of power loss due to the failure of two primary pumps. A preliminary study is made on the stability limits of the secondary circuit of the steam generator. Reactivity-period curves are prepared at various irradiation levels for the first cycle. (tr-auth)

38427 (FN-E-78) PROGRESS REPORT NO. 2 ON THE INTEGRATED RESEARCH PROGRAM OF THE E. FERMI PLANT, QUARTERLY, JANUARY-MARCH 1967. (FIAT, Turin (Italy). Sezione Energia Nucleare). 41p. (In Italian). Dep. CFSTI (U. S. Sales Only).

The verification of some critical conditions for the start-up of the first core is completed. From comparison with available data on the power coefficients, an empirical relation is obtained for the efficient temperature as a function of the power to be utilized in the calculation of the Doppler effect. From the analyses of the calculated values, a first polynomial correlation is obtained for the boron coefficients to be used in the PRODAC program on the reactivity balance. The evaluation of the long-term reactivity variation gives the prediction of a duration of the first cycle of 11,500 Mwd/t which is in good agreement with experimental data. The fuel consumption at the end of the first cycle is evaluated. The calculation of the axial form of the flux is made in monodimensional approximation. The comparison with the Aeroball results shows an error in the theoretical predictions of about 5%. The power distribution predicted for the beginning of the second cycle is evaluated. The reference value of the total coolant capacity and consequently the calculation of the capacity distribution at the interior of the fuel elements are brought up to date. The study of the stability of the steam generators is continued with the analysis of new experimental results. The comparison with a preliminary study reveals a sharp discrepancy between theoretical predictions and experimental results with respect to the oscillation frequency of the water level. A statistical analysis is made of the experimentally detected errors in the instrumentation. (tr-auth)

38428 (FN-E-83) PROGRESS REPORT NO. 3 ON THE INTEGRATED RESEARCH PROGRAM OF THE E. FERMI PLANT, QUARTERLY, APRIL-JUNE 1967. (FIAT, Turin (Italy). Sezione Energia Nucleare). 119p. (In Italian). Dep. CFSTI (U. S. Sales Only).

The analysis of the experimental results is presented with the data from the Aeroball runs toward the end of the first cycle. The comparison between the first approximation calculated results and the experimental results is sufficiently good with respect to the radial and axial distribution of the thermal flux. The discrepancy found is attributed to the hypothesis of the separability of the radial and axial flux in the presence of deeply inserted control rods. Some preliminary theoretical results of radial and axial factors of a heated channel are presented for the second cycle. The analysis of the power redistribution at the interior of the core is completed. The analysis of the power redistribution using a model with open channels is extended to the case of density variation of the coolant along the channel. The data obtained from ENEL on the characteristic curve of the secondary system (relation between the average minimum temperature in the primary and thermal power transferable to the secondary) are verified. The base criteria for the thermohydraulic design of the core and a series of values for the engineering factors of the hot channel are defined. A study is made of the safety of the core. The core safety in the case of an incident of coolant loss due to the shutdown of two pumps is verified. The statistical analysis of the experimentally detected errors in the instrumentation is completed. (tr-auth)

38429 (FN-E-87) PROGRESS REPORT NO. 4 ON THE INTEGRATED RESEARCH PROGRAM OF THE E. FERMI PLANT, QUARTERLY, JULY-SEPTEMBER 1967. (FIAT, Turin (Italy). Sezione Energia Nucleare). 53p. (In Italian). Dep. CFSTI (U. S. Sales Only).

The calculation of the constants for the evaluation of the reactivity is presented. The epithermal and thermal weight statistical factors at 10,500 MWD/MTU are calculated. During the test on the effect of the pH variation of the primary coolant on the reactivity, an accidental scram caused significant variations in the Xenon concentrations. The total reactivity loss associated with the reduction of pH was about 0.32%. A preliminary analysis is made on local boiling in the core and the effect of crud. The cellular power distribution in the fuel element having the maximum mean thermal flux and in fuel elements having the maximum cellular power is presented. The distribution of the temperature in the vicinity of various fuel elements is calculated. A digital program of the plant dynamics with conservative representation of the thermal kinetics of the hot point is developed and tested. The results of the calculation of a stimulated incident of rod extraction at power are presented. The temperature distribution in the canning and in the fuel of the central channel and at the hot point is calculated. The total efficiency of the control group is recalculated with the PDQ code in x-y geometry. The values obtained reproduce satisfactorily the experimental data. Some results on the temperature coefficients of the coolant and boron at 7000 and 10,500 MWD/MTU are reported. (tr-auth)

38430 (FN-E-93) PROGRESS REPORT NO. 5 ON THE INTEGRATED RESEARCH PROGRAM OF THE E. FERMI PLANT, QUARTERLY, OCTOBER-DECEMBER 1967. (FIAT, Turin (Italy). Sezione Energia Nucleare). 29p. (In Italian). Dep. CFSTI (U. S. Sales Only).

The two-group weight statistical factors are presented as a function of the burnup for each region at various enrichments. The temperature coefficient of the coolant during the test of pH variation is recalculated using the experimental data of the rod efficiency. Some modifications are made to the MELE code to make the calculation of the Xenon reactivity more automatic. The effect of the axial distribution of the density of the moderator on the axial profile of the normalized thermal flux is calculated with a monodimensional burnup code. The differential

efficiency of the control group, calculated with a monodimension diffusion code, shows good agreement with experimental data. The temperature coefficients of the coolant and boron at 7000 and 10,500 MWD/MTU are recalculated by means of a new method of evaluation of the absorption of fission products. (tr-auth)

38431 (FN-E-99) PROGRESS REPORT NO. 6 ON THE INTEGRATED RESEARCH PROGRAM OF THE E. FERMI PLANT, QUARTERLY, JANUARY–MARCH 1968. (FIAT, Turin (Italy). Sezione Energia Nucleare). 81p. (In Italian). Dep. CFSTI (U. S. Sales Only).

The final results and evaluations of the tests on pH variation are presented. With the use of a monodimensional burnup code, the effect of the axial distribution of the moderator density on the axial profile of the normalized thermal flux is calculated with the greatest accuracy possible and confirms the preliminary results obtained previously. The comparison of the axial profile obtained during the Aeroball runs appears satisfactory. The absence of the control rods during the charge reduction represents an ideal condition to determine the Doppler coefficient. The reactivity associated with the Xenon during and after the two power transients is calculated. (tr-auth)

38432 (FN-E-102) PROGRESS REPORT NO. 7 ON THE INTEGRATED RESEARCH PROGRAM OF THE E. FERMI PLANT, QUARTERLY, APRIL–JUNE 1968. (FIAT, Turin (Italy). Sezione Energia Nucleare). 49p. (In Italian). Dep. CFSTI (U. S. Sales Only).

By the use of the results of a monodimensional burnup calculation, the axial burnup distributions in three characteristic periods of the first cycle are determined. The comparison with the distributions obtained from ENEL on the basis of the Aeroball data, limited to a single fuel element, appears satisfactory. The element per element distribution of the final burnup of a fourth of the core, obtained from a bidimensional calculation and compared with experimental results, shows some discrepancies of as yet undetermined origin. The analyses of the spatial distributions of the flux obtained from calculations in RZ geometry are initiated to verify the hypothesis of separability. The first results obtained show a good qualitative agreement with the experimental distributions of the separability factor S, confirming the validity of the hypothesis in the non-perturbed regions of control rods and of reflection conditions at the boundary. Some preliminary results of a method of calculation of the mean effective temperature of the fuel and of the power coefficients at the beginning of the first cycle are presented. (tr-auth)

38433 (FN-E-105) PROGRESS REPORT NO. 8 ON THE INTEGRATED RESEARCH PROGRAM OF THE E. FERMI PLANT, QUARTERLY, JULY–SEPTEMBER 1968. (FIAT, Turin (Italy). Sezione Energia Nucleare). 47p. (In Italian). Dep. CFSTI (U. S. Sales Only).

The feasibility of a tridimensional calculation by means of the TRITON code is studied for the analysis of the power density distribution. The TRITON permits a maximum of 8000 lattice points, and it can represent the Trino reactor. Bidimensional and monodimensional calculations are made to establish an x-y lattice and one in z with a minimum number of points and the minimum errors. It was possible to define a $25 \times 25\ 12 = 7500$ lattice which gives a local maximum error of 3 to 4%. The principal characteristics of the monodimensional burnup code SQUIRREL are reported. This code constitutes an improved version of the MELE-4 code previously used in the analysis of the axial distribution of power of the Trino reactor. The control rod-Xenon interaction is studied for the core configuration existing during the pH test of October 1966. (tr-auth)

38434 (FN-E-108) PROGRESS REPORT NO. 9 ON THE INTEGRATED RESEARCH PROGRAM OF THE E. FERMI PLANT, QUARTERLY, SEPTEMBER–DECEMBER 1968. (FIAT, Turin (Italy). Sezione Energia Nucleare). 17p. (In Italian). Dep. CFSTI (U. S. Sales Only).

The cellular calculations for the determination of the nuclear constants to be used in the reactivity balance program of the ENEL are initiated. With the monodimensional burn-up code SQUIRREL, a series of calculations on the distribution of the neutron flux in slab and cylindrical geometry is described. The differential efficiency of the control group to the irradiation of 8200 MWD/t with various spatial distributions of Xenon is evaluated. (tr-auth)

38435 (KFK-1147) NUCLEAR ENERGY REQUIREMENTS OF THE WORLD, AN ANALYSIS OF FUTURE MARKET POTENTIALS. Zajonc, Horst (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Reaktorphysik). Feb 1970. 53p. (In German). Dep. CFSTI (U. S. Sales Only).

A forecast of the world's total electrical power requirements up to the year 2000 is presented. This forecast is based on population growth and per capita power consumption. The nuclear share of total power was determined in accordance with the published views of a number of experts. An independent forecast is presented for each group of nations, classified as highly industrialized, industrialized, rapidly developing, developing and the Communist ones. The world forecast, derived by aggregation over these groups, was found to differ by no more than 10 to 15% from the previous forecast. In addition, comments on export potentials for nuclear power stations for each of the groups are given. The current market situation is reviewed. A brief history is included of the development of nuclear power, and previous export sales, of each of the main export countries: USA, Great Britain, Canada, France, G.F.R. and the USSR. (auth)

38436 (NP-18261) TRINO VERCELLESE NUCLEAR POWER PLANT RESEARCH PROGRAM FOR THE DEVELOPMENT OF CLOSED-CYCLE WATER REACTOR TECHNOLOGY. Quarterly Technical Report No. 1, June–September 1966. (Ente Nazionale per l'Energia Elettrica, Rome (Italy). Oct 1966. 35p. (In Italian). Dep. CFSTI (U. S. Sales Only).

The work done in the period between June 1, 1966, and September 30, 1966, on the development of the technology of a closed-cycle water reactor is reported. The development of the theoretical model for the reactivity balance of the reactor is described. A test for the evaluation of the reactivity variation induced by a variation of the alkali concentration in the primary coolant is prepared. A systematic analysis is made of the measurements obtained by means of the Aeroball system. A method to evaluate the back scattering effect produced by the source on the scintillation counter is described. An analysis is made of the data obtained in the normal operation of the plant in order to determine the precision of the radiation protection devices. (tr-auth)

38437 (NP-18262) TRINO VERCELLESE NUCLEAR POWER PLANT RESEARCH PROGRAM FOR THE DEVELOPMENT OF CLOSED-CYCLE WATER REACTOR TECHNOLOGY. Quarterly Technical Report No. 2, October–December 1966. (Ente Nazionale per l'Energia Elettrica, Rome (Italy). Jan 1967. 105p. (In Italian). Dep. CFSTI (U. S. Sales Only).

The work done in the period between October 1, 1966, and December 31, 1966, on the development of the technology of a closed-cycle water reactor is reported. The general characteristics of the reactivity balance program is examined with particular reference to the temperature coefficient. The effect of the control rods and of the Xenon is also examined with reference to a zero-dimensional two-group model. A preliminary analysis is made of the results of the test on the pH variation. The possible causes of error of the Aeroball system are examined to determine its degree of precision. The tests to evaluate the operational limits of the core are described. The coefficients of temperature and power are determined for the core. The criteria for the evaluation of the instrument errors of the protection and control systems are examined. (tr-auth)

38438 (NP-18263) TRINO VERCELLESE NUCLEAR POWER PLANT RESEARCH PROGRAM FOR THE DEVELOPMENT OF CLOSED-CYCLE WATER REACTOR TECHNOLOGY. Quarterly Technical Report No. 3, January–March 1967. (Ente Nazionale per l'Energia Elettrica, Rome (Italy). Apr 1967. 60p. (In Italian). Dep. CFSTI (U. S. Sales Only).

The work done in the period between January 1, 1967, and March 31, 1967, on the development of the technology of a closed-cycle water reactor is reported. The analysis of the neutron flux noise found during operation at high and low pH is presented. The program for inspection of fuel elements and other reactor components is defined. The data available for the determination of the total exchange coefficient of the steam generator are analyzed. Physical characteristics of the core operating with chemical control are determined. (tr-auth)

38439 (NP-18264) TRINO VERCELLESE NUCLEAR POWER PLANT RESEARCH PROGRAM FOR THE DEVELOPMENT OF CLOSED-CYCLE WATER REACTOR TECHNOLOGY. Quarterly Technical Report No. 5, July–September 1967. (Ente Nazionale per l'Energia Elettrica, Rome (Italy). Oct 1967. 100p. (In Italian). Dep. CFSTI (U. S. Sales Only).

The work done in the period between July 1, 1967, and September 30, 1967, on the development of the technology of a closed-cycle water reactor is reported. The analysis of the reactivity coefficients is presented. A total γ scanning is made of some fuel elements. The construction of the special instrumentation for the determination of the potential of the steam generator is described. Studies on the physical characteristics of the core are included, and the power coefficient between 825 and 0 MW(t) is determined. The increase of the burnup rate is also determined. The effects of a failure of a control rod on the power distribution of the core and on the signals of the ionization chamber are studied. (tr-auth)

38440 (NP-18265) TRINO VERCELLESE NUCLEAR POWER PLANT RESEARCH PROGRAM FOR THE DEVELOPMENT OF CLOSED-CYCLE WATER REACTOR TECHNOLOGY. Quarterly Technical Report No. 6, October–December 1967. (Ente Nazionale per l'Energia Elettrica, Rome (Italy). Jan 1968. 70p. (In Italian). Dep. CFSTI (U. S. Sales Only).

The work done in the period between October 1, 1967, and December 31, 1967, on the development of the technology of a closed-cycle water reactor is reported. The results of the analysis of neutron flux noise are reported. The axial distribution of radiation at the end of the first cycle is calculated for the fuel element No. 91. The axial distribution of the γ radiation in the same element is calculated five months after the shutdown of the reactor in order to make a comparison with the activity experimentally determined in September 1967. Some measurements on the specific conductivity of the liquid phase of the secondary side of the steam generator are analyzed in order to derive the relation between the void volume and the power or mean temperature of the primary coolant. The processing of the data collected during the EP-29 test is continued in order to determine the effect of a failure of a control rod on the power distribution of the core and on the signals of the ionization chamber. (tr-auth)

38441 (NP-18266) TRINO VERCELLESE NUCLEAR POWER PLANT RESEARCH PROGRAM FOR THE DEVELOPMENT OF CLOSED-CYCLE WATER REACTOR TECHNOLOGY. Quarterly Technical Report No. 7, January–March 1968. (Ente Nazionale per l'Energia Elettrica, Rome (Italy). Apr 1968. 75p. (In Italian). Dep. CFSTI (U. S. Sales Only).

The results of the analyses of the neutron flux noise made at constant power and average temperature of the variable primary coolant are reported. The radial distribution of the irradiation element by element is calculated at the end of the first cycle. The calculation is made by using the integrals of the activation profiles furnished by the Aeroball system during the first cycle. By use of the same data the calculation of the radial distribution of the γ activity of the fuel element five months after reactor shutdown was initiated. A synthesis method for the flux is proposed for the analysis of the data from the instrumentation inside the core. (tr-auth)

38442 (NP-18267) TRINO VERCELLESE NUCLEAR POWER PLANT RESEARCH PROGRAM FOR THE DEVELOPMENT OF CLOSED-CYCLE WATER REACTOR TECHNOLOGY. Quarterly Technical Report No. 9, [July–September 1968]. (Ente Nazionale per l'Energia Elettrica, Rome (Italy). Oct 1968. 31p. (In Italian). Dep. CFSTI (U. S. Sales Only).

The work done in the period between July 1, 1968, and September 30, 1968, on the development of the technology of a closed-cycle water reactor is reported. The study of the protection and control systems is presented. (tr-auth)

38443 (NP-18268) TRINO VERCELLESE NUCLEAR POWER PLANT RESEARCH PROGRAM FOR THE DEVELOPMENT OF CLOSED-CYCLE WATER REACTOR TECHNOLOGY. Quarterly Technical Report No. 10, October–December 1968. (Ente Nazionale per l'Energia Elettrica, Rome (Italy). Jan 1969. 45p. (In Italian). Dep. CFSTI (U. S. Sales Only).

The work done in the period between October 1, 1968, and December 31, 1968, on the development of the technology of a closed-cycle water reactor is reported. The transfer function is determined by means of a pseudo-random displacement of the control rod. The method to evaluate statistically the effect of errors and drifts of the instrumentation on the various time-dependent nuclear magnitudes is studied. (tr-auth)

38444 (NP-18269) TRINO VERCELLESE NUCLEAR POWER PLANT RESEARCH PROGRAM FOR THE DEVELOPMENT OF CLOSED-CYCLE WATER REACTOR TECHNOLOGY. Quarterly Technical Report No. 11, January–March 1969. (Ente Nazionale per l'Energia Elettrica, Rome (Italy). Apr 1969. 45p. (In Italian). Dep. CFSTI (U. S. Sales Only).

The work done in the period between January 1, 1969, and March 31, 1969, on the development of the technology of a closed-cycle water reactor is reported. Studies on the reactivity balances, test of surface boiling, behavior of the plant materials and post-irradiation tests, and physical characteristics of the core operating with chemical control are described. (tr-auth)

38445 (NP-18270) TRINO VERCELLESE NUCLEAR POWER PLANT RESEARCH PROGRAM FOR THE DEVELOPMENT OF CLOSED-CYCLE WATER REACTOR TECHNOLOGY. Quarterly Technical Report No. 12, April–June 1969. (Ente Nazionale per l'Energia Elettrica, Rome (Italy). Jul 1969. 88p. (In Italian). Dep. CFSTI (U. S. Sales Only).

The work done in the period between April 4, 1969, and June 30, 1969, on the development of the technology of a closed-cycle water reactor is reported. The dependence of the various radiation magnitudes, boron concentration, and temperature is expressed in the form of polynomial expansions. The neutron noise during the EP-109 test is analyzed to determine the dependence of the core power on the peak frequency at about 5 Hz. A numerical program for the on-line calculation of the power density spectra is described. The design, fabrication, installation, testing, and initiation of the machinery necessary for extracting and dismantling the fuel elements are described. (tr-auth)

38446 NUCLEAR TECHNOLOGY COMPONENTS IN PRACTICAL USE. REQUIREMENTS AND TEST RESULTS. Atomwirt.; Atomtech.; 15: 265-8(Jun 1970). (In German).

Based on answers to a questionnaire that was sent to nuclear power plants, reactor manufacturers, and subcontractors, difficulties and their solutions in nuclear installations were discussed. In the production of reactor components, three aspects proved significant: quality of material, delivery dates, and operational performance. Initially, insufficient quality, caused by lack of experience in both organization and labor, was a major factor. These deficiencies caused fluid vibrations in the primary circuit and pressure vessel, corrosion in the heat exchanger, failure of pumps and valves, and difficulties in the operation of control rod and fuel element exchanger. With increasing experience the problems were largely overcome. Briefly analyzed were delays in delivery dates, planning of the installation, new types of materials, construction of the plant, welding, monitoring and testing, supply of spare components for repairs, and D_2O pumps. Principles of organization and management for future power plants were derived from previous experiences. (H.B.G.)

38447 EXPERIENCE WITH NUCLEAR POWER PLANT COMPONENTS. RESULTS AND CONCLUSIONS FROM BUILDING, STARTUP, AND MANAGEMENT OF INSTALLATIONS IN COUNTRIES OF THE EUROPEAN COMMUNITY. Siebker, M. Atomwirt.; Atomtech.; 15: 270-2(Jun 1970). (In German).

The Commission of the European Community established close exchange of experience with reactor operations. The experience comprised seventeen plants in operation: five boiling water reactors, four pressure water reactors, five CO_2-cooled graphite reactors, one gas-cooled high temperature reactor, and two heavy water reactors. Overall operation of nuclear power plants compared favorably with conventional power stations. Minor problems encountered and proposals for future improvements were listed. Especially emphasized were containing vessels and their connections, pressure vessels, corrosion problems in CO_2-cooled graphite reactors, fuel elements, monitoring and controls, control rods and control mechanisms, heat exchanger with pumps and valves, turbogenerator unit, and treatment of water, gas, and waste products. Conclusions from the present operational data were summarized and principles for future installations were derived. (H.B.G.)

Safety and Siting

Refer also to abstract 36390.

38448 (CONF-700317, Paper 16) LICENSING NUCLEAR POWER PLANTS. Ehrenpreis, S. N. (Westinghouse Electric Corp., East Pittsburgh, Pa.). 22p.

From 1970 electric utility engineering conference, East Pittsburgh, Pa. Vol. III.

Licensing procedures and requirements for nuclear power plants in the U. S. are reviewed. The licensing status for each Westinghouse pressurized-water power reactor is listed. Quality assurance program requirements are described. (D.C.C.)

38449 (DOCKET-50029-120) YANKEE NUCLEAR POWER STATION. License Application, Proposed Change No. 91. (Yankee Atomic Electric Co., Westboro, Mass.). 14 Jul 1970. 5p. Dep. CFSTI.

Revised specifications for the auxiliary power systems are described. (D.C.C.)

38450 (DOCKET-50029-122) YANKEE NUCLEAR POWER STATION. License Application, Proposed Change No. 94. (Yankee Atomic Electric Co., Westboro, Mass.). 15 Jul 1970. 8p. Dep. CFSTI.

Core loading specifications for Core 9 operation are presented. Revised thermal characteristics and control requirements for Core 9 are described. (D.C.C.)

38451 (DOCKET-50237-56) DRESDEN NUCLEAR POWER STATION, UNIT 2. Proposed Change No. 3 to Appendix A of DPR-19. (Commonwealth Edison Co., Chicago, Ill.). 10 Jul 1970. 2p. Dep. CFSTI.

A change in the trip level setting of the instrumentation that initiates primary containment isolation is proposed. (H.D.R.)

38452 (DOCKET-50237-57) DRESDEN NUCLEAR POWER STATION, UNIT 2. Low Pressure Coolant Injection System

Inoperable. (Commonwealth Edison Co., Chicago, Ill.). 17 Jul 1970. 2p. Dep. CFSTI.

38453 (DOCKET-50237-58) DRESDEN NUCLEAR POWER STATION, UNIT 2. Review of Furnace-Sensitized Stainless Steel Components. (Division of Reactor Licensing (AEC), Washington, D. C.). 24 Jul 1970. 5p. Dep. CFSTI.

38454 (DOCKET-50247-36) INDIAN POINT NUCLEAR GENERATING UNIT NO. 2. Preliminary Safety Analysis Report, Amendment 19 (Includes Final Facility Description and Safety Analysis Report, Suppl. 10. (Consolidated Edison Co. of New York, Inc., New York). 14 Jul 1970. 451p. Dep. CFSTI.

Revised and additional thermal and hydraulic design parameters are presented. Flood hazards for the reactor site are analyzed. (D.C.C.)

38455 (DOCKET-50266-25) POINT BEACH NUCLEAR PLANT, UNITS 1 AND 2. Environmental Studies. Report No. PBR 1. (Wisconsin Univ., Milwaukee. Dept. of Botany). Mar 1970. 81p. (DOCKET-50301-21). Dep. CFSTI.

For Wisconsin Electric Power Co., Milwaukee and Wisconsin Michigan Power Co., Appleton, Wis.

38456 (DOCKET-50267-18) FORT ST. VRAIN NUCLEAR GENERATING STATION, UNIT 1. Preliminary Safety Analysis Report, Amendment 15. (Public Service Co. of Colorado, Denver). 18 Jun 1970. 396p. Dep. CFSTI.

The fourth and fifth pre-operational environmental radiation surveillance program quarterly reports, covering the period october 1969 through March 1970, are presented. Gross beta analyses on air, water, forage, and bottom sediments and specific radionuclide analyses on a qualitative basis are included. Revised and additional data for the Final Safety Analysis Report (FSAR) are presented. Appendix F of the FSAR, Proposed Technical Specifications, pertaining to the operation of the plant is included. (H.D.R.)

38457 (DOCKET-50269-18) OCONEE NUCLEAR STATION, UNITS 1, 2, AND 3. Preliminary Safety Analysis Report, Amendment 15 (Includes Final Safety Analysis Report, Rev. 7). (Duke Power Co., Charlotte, N. C.). 9 Jul 1970. 176p. (DOCKET-50270-18; DOCKET-50287-15). Dep. CFSTI.

Included is a new Appendix 7A to the Final Safety Analysis Report (FSAR). The appendix pertains to environmental and seismic qualification testing for the nuclear instrumentation/reactor protection system equipment and for the engineered safeguards protective system equipment. Also included is FSAR Supplement 4 to provide additional information in response to AEC questions and volunteered additional information. (H.D.R.)

38458 (DOCKET-50269-19) OCONEE NUCLEAR STATION, UNITS 1, 2, AND 3. Environmental Quality Features of Keowee-Toxaway Project. (Duke Power Co., Charlotte, N. C.). 10 Jul 1970. 14p. (DOCKET-50270-19; DOCKET-50287-16). Dep. CFSTI.

The environmental impact of the Keowee-Taxaway Project, of which the Oconee Nuclear Station is an integral part, is discussed. The project lies along the Keowee River in Oconee and Pickens Counties, South Carolina, and Transylvania County, North Carolina. The overall plan includes two major lakes, several small reservoirs, electric generating capacity of about 10 million kilowatts, and the development of 150,000 acres of surrounding land. There are no adverse environmental effects that will result from either the entire project or the Oconee plant. (H.D.R.)

38459 (DOCKET-50271-24) VERMONT YANKEE NUCLEAR POWER STATION. Reactor Pressure Vessel Design Report. Preliminary Safety Analysis Report, Amendment 13-III. (Vermont Yankee Nuclear Power Corp., Rutland). 10 Jul 1970. 216p. Dep. CFSTI.

38460 (DOCKET-50277-10) PEACH BOTTOM ATOMIC POWER STATION, UNITS 2 AND 3. Concrete Strength Survey Report. (Bechtel Corp., San Francisco, Calif.). Jun 1970. 182p. (DOCKET-50278-10). Dep. CFSTI.

For Philadelphia Electric Co., Pa.

Some concrete in the Peach Bottom Atomic Power Station which was conveyed via aluminum pump line showed low strengths. In some areas strength reductions were as great as 50 percent. Aluminum abraided from the aluminum pump line reacted with the alkali products in the concrete. This reaction produced small hydrogen bubbles in the concrete. Several samples of low strength concrete showed microfissures when examined by petrographic methods. These microfissures are believed to be caused by the release of hydrogen after initial set, and to be the cause of the low strength. To document and determine the extent of affected concrete, drilled cores for compression tests were taken from critical and suspect areas. A program of non-destructive testing by means of a Swiss hammer was conducted to survey all concrete placed before the use of aluminum pipe was discontinued. A chronologic review of the concrete that was pumped through aluminum pipe showed that strength loss progressed with time. This was probably due to the progressive wearing of the hard interior surface of the pipe which allowed more aluminum to be introduced into the concrete. A structural design review of concrete strength requirements showed that some concrete in the biological shield and in a concrete floor slab in the Turbine Building were seriously affected. Remedial action was taken to correct the situation. The core and Swiss hammer surveys are considered adequate to locate all the low strength concrete. All concrete satisfies the structural and serviceability requirements with the remedial action taken. (auth)

38461 (DOCKET-50285-25) FORT CALHOUN REACTOR. Pre-Operational Environmental Survey. Sixth Report, 1st Quarter 1970. (Trapelo/West, Richmond, Calif.). 26 May 1970. 17p. Dep. CFSTI.

For Omaha Public Power District, Nebr.

38462 (DOCKET-50289-25) THREE MILE ISLAND NUCLEAR STATION, UNIT 1. Preliminary Safety Analysis Report, Amendment 14 (Includes Final Safety Analysis Report, Suppl. 1). (Metropolitan Edison Co., Reading, Pa. Jersey Central Power and Light Co., Morristown, N. J.). 1 Jul 1970. 153p. Dep. CFSTI.

Insert pages and Supplement 1 to the Final Safety Analysis Report are presented. Supplement 1 describes the acceptability of the reactor building spray system for iodine removal, an evaluation of containment purging for hydrogen control following an accident, and a probabilistic evaluation of accident doses using site measured meteorological data. (H.D.R.)

38463 (DOCKET-50309-19) MAINE YANKEE ATOMIC POWER STATION. Report on Probable Maximum Flood Elevation Resulting from the Probable Maximum Hurricane. (Maine Yankee Atomic Power Co., Westboro, Mass.). 24 Jun 1970. 68p. Dep. CFSTI.

The maximum water levels at the Maine Yankee Atomic Power Station due to the probable maximum hurricane are predicted to be at El. 19.9 and El. 21.4 on the plant site and screen well structure, respectively. These levels are based upon the simultaneous occurrence of the maximum storm surge, the maximum predicted astronomical tide, an initial rise in mean sea level, estuarian amplification, the probable maximum flood in the Sheepscot River watershed and maximum waves in Montsweag Bay. Since the floor grade of the principal power station structures and the plant yard are at El. 21.0 and El. 20.0, respectively, and since protection will be provided at the screen well to El. 22.0, there will be no significant flood risk at this site. (auth)

38464 (DOCKET-50335-16) HUTCHINSON ISLAND PLANT, UNIT NO. 1. Construction Permit No. CPPR-74. (Division of Reactor Licensing (AEC), Washington, D. C.). 1 Jul 1970. 28p. Dep. CFSTI.

38465 (DOCKET-50344-12) TROJAN NUCLEAR PLANT. Preliminary Safety Analysis Report, Amendment 8. (Portland General Electric Co., Oreg.). 6 Jul 1970. 51p. Dep. CFSTI.

Amended and supplementary material on design and operational aspects of the Trojan plant is presented. (H.D.R.)

38466 (DOCKET-50344-13) TROJAN NUCLEAR PLANT. Amendment No. 1 to the Application for License. (Portland General Electric Co., Oreg.). 6 Jul 1970. 31p. Dep. CFSTI.

Financial data on the owners of the Trojan Power Reactor Unit 1 are given in support of the application for construction permit and operating license. The 1969 Annual Report for the Portland General Electric Company is included. (D.C.C.)

38467 (DOCKET-50346-11) DAVIS-BESSE NUCLEAR POWER STATION. Preliminary Safety Analysis Report, Amendment 7. (Toledo Edison Co., Ohio). 29 Jun 1970. 117p. Dep. CFSTI.

Revised and additional information is presented on the following subjects: quality assurance program; foundation design criteria; engineered safeguards; and reactor systems. (D.C.C.)

38468 (DOCKET-50348-6) JOSEPH M. FARLEY NUCLEAR PLANT, UNIT 1. Preliminary Safety Analysis Report, Amendment 1. (Alabama Power Co., Birmingham). 26 Jun 1970. 86p. Dep. CFSTI.

Formerly SEALA Nuclear Plant, Unit No. 1.

Financial data on the owners of the Joseph M. Farley Power Reactor Unit 1 are given in support of the application for construction permit and operating license. The 1969 Annual Reports for the Alabama Power Company and the Southern Company are included. (D.C.C.)

38469 (DOCKET-50348-7) JOSEPH M. FARLEY NUCLEAR PLANT, UNIT 1 AND 2. License Application, Amendment No. 2.

(Alabama Power Co., Birmingham). 16 Jul 1970. 89p. (DOCKET-50364-1). Dep. CFSTI.
Formerly SEALA Nuclear Plant, Unit No. 1.

Power Reactor Development

Refer also to abstracts 36196, 36198, 36347, 36529, 36552, 36642–36644, 36858, 36870–36872, 36893, 36945, and 37001.

38470 (ANL-7688) REACTOR DEVELOPMENT PROGRAM PROGRESS REPORT, APRIL–MAY 1970. (Argonne National Lab., Ill.). 14 Jul 1970. Contract W-31-109-eng-38. 253p. Dep. CFSTI.

Highlights of project activities for April and May 1970 are summarized. LMFBR physics development and component development are reviewed. Operations and analysis of ZPR-3, ZPR-6, ZPR-9, and ZPPR are described. The EBR-2 research and development projects, fuel fabrication, and operations are summarized. Reactor fuels and materials development, physics studies, engineering development, fuel cycle chemistry, and LMFBR safety studies are reported. (D.C.C.)

38471 (BNWL-1424) PNL-17: EBR-II INSTRUMENTED SUBASSEMBLY TEST. INTERIM REPORT. Millhollen, M. K.; Sutey, A. M. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jun 1970. Contract AT(45-1)-1830. 41p. Dep. CFSTI.

PNL-17 is a 37-pin, instrumented subassembly being irradiated in EBR-II with thermocouples substituted for wire wrap on several of the pins. Hot junctions are so arranged that temperature readings are taken at both 1.5 and 6.0 in. above the bottom of the fuel column within selected coolant subchannels. The maximum calculated linear pin power generation is 9.20 kW ft; sodium coolant inlet temperature is 700°F, and coolant flow through the subassembly is 53.3 gpm. Subchannel coolant temperature readings at 20 MW and 50 MW reactor power levels early in the life of the subassembly have been corrected for thermocouple calibration and compared with values calculated by the COBRA II A Program. Correlation has been extremely good in most cases. The comparison of measured and calculated temperatures indicates that calculational methods being used to predict coolant channel performance of fuel test assemblies in EBR-II are satisfactory. (auth)

38472 (DP-Report-63) ENGINEERING ASPECTS OF THE DRAGON REACTOR EXPERIMENT. Project DRAGON. Lockett, G. E. (Atomic Energy Establishment, Winfrith (England)). Nov 1961. 26p. Dep. CFSTI.

Design parameters of the High-Temperature Gas-Cooled Reactor Experiment are listed. Design problems are described. (D.C.C.)

38473 (DP-Report-75) RESEARCH AND DEVELOPMENT DIVISION SECOND SEMI-ANNUAL REPORT FOR PERIOD JANUARY 1 TO JUNE 30, 1961. Project DRAGON. Marien, P. (ed.). (Atomic Energy Establishment, Winfrith (England)). Feb 1962. 377p. Dep. CFSTI.

The work of the DRAGON Project Research and Development Division is reported under the following headings: theoretical studies; reactor safety and kinetics; experimental reactor physics; heat transfer experiments; carbon mass transport; coolant processing; fission products; graphite; fuel elements; materials, instruments, techniques; component development; in-pile experiments; and the 7-element experiment. (auth)

38474 (DP-Report-92) RESEARCH AND DEVELOPMENT DIVISION THIRD SEMI-ANNUAL REPORT FOR PERIOD JULY 1, 1961 TO DECEMBER 31, 1961. Project DRAGON. Marien, P. (ed.). (Atomic Energy Establishment, Winfrith (England)). May 1962. 324p. Dep. CFSTI.

The work of the DRAGON Project Research and Development Division is reported under the following headings: Reactor Physics; Reactor Safety; Heat Transfer and Gas Dynamics; Carbon Mass Transport; Coolant Processing; Graphite; Fuel Elements; Materials, Instruments and Techniques; Component Development; Irradiation Program; Pluto and Dido Loops; and The Seven-Element Experiment. (auth)

38475 (DP-Report-115) RESEARCH AND DEVELOPMENT DIVISION FOURTH SEMI-ANNUAL REPORT FOR PERIOD JANUARY 1, 1962 TO JUNE 30, 1962. Project DRAGON. Marien, P. (ed.). (Atomic Energy Establishment, Winfrith (England)). Nov 1962. 382p. Dep. CFSTI.

The work of the DRAGON Project Research and Development Division is reported under the following headings: Reactor Physics; Heat Transfer and Gas Dynamics; Carbon Transport; Coolant Processing; Graphite; Fuel Elements; Materials, Instruments and Techniques; Component Development; Irradiation Programme; Pluto and Dido Loops; The Seven Element Experiment; and Power Reactor Assessment. (auth)

38476 (DP-Report-135(Pt.1)) THE CIVIL H.T.R. REFERENCE DESIGN STUDY. Project DRAGON. Thorn, J. D. (ed.). (United Kingdom Atomic Energy Authority, Risley (England). Reactor Group). Jan 1963. 97p. Dep. CFSTI.
For Atomic Energy Establishment, Winfrith, Eng.

Design parameters for the 1000 MW(e) reference design high temperature gas-cooled reactor are presented. (D.C.C.)

38477 (DP-Report-162) THE DESIGN AND OPERATION OF THE CORE UNCLAMP MECHANISM OF THE DRAGON REACTOR. Project DRAGON. Hart, J. D. (Atomic Energy Establishment, Winfrith (England)). Mar 1963. 46p. Dep. CFSTI.

The Core Unclamp Mechanism is a pneumatically actuated system which permits the top of the Inner Live Reflector to be moved free of the adjacent Fuel Elements of the Dragon Reactor Core. Design objectives are presented with the particular aim of enabling an operator to obtain a full understanding of the system. A brief historical record of the development of the design precedes the detailed description of the finally adopted design. The safeguards and limitations are presented and sequences of operation listed. The possible scope of maintenance, repair or replacement of items is discussed. Appendices are included giving details of all tests which have been conducted to support the design or on the actual equipment. Also included are some of the rudimentary design calculations. (auth)

38478 (DP-Report-165) RESEARCH AND DEVELOPMENT DIVISION FIFTH SEMI-ANNUAL REPORT, JULY 1, 1962 TO DECEMBER 31, 1962. Project DRAGON. Marien, P. (ed.). (Atomic Energy Establishment, Winfrith (England)). May 1963. 350p. Dep. CFSTI.

The work of the DRAGON Project Research and Development Division is reported under the following headings: Reactor Physics; Heat Transfer and Gas Dynamics; Carbon Transport; Coolant Processing; Graphite; Fuel Elements; Materials, Instruments and Techniques; Component Development; Irradiation Programme; PLUTO and DIDO Loops; and The Seven Element Experiment. (auth)

38479 (DP-Report-189) THE FEASIBILITY OF USING MOLECULAR SIEVE 4A PELLETS FOR THE REMOVAL OF CO_2 AND H_2O-VAPOUR FROM AN H.T.G.R. PURGE. Project DRAGON. Roemberg, E. (Atomic Energy Establishment, Winfrith (England)). Apr 1963. 18p. Dep. CFSTI.

The feasibility of using Molecular Sieve material 4Å for selective adsorption of CO_2 and H_2O-vapour from highly contaminated reactor coolants is examined. In the Dragon Experiment the removal of these impurities is done by low temperature freezing techniques, however, the present results indicate that Molecular Sieves 4Å adsorbers can be considered as an attractive alternative to the Dragon freezer concept. (auth)

38480 (DP-Report-237) TEMPERATURE MEASUREMENT IN THE REACTOR PIT. Project DRAGON. Giordano, P. G. (Atomic Energy Establishment, Winfrith (England)). Dec 1963. 47p. Dep. CFSTI.

All the temperature measurements made in the reactor area are presented. Descriptions of all the special features necessary to install the sensing elements and to perform the measurements are included. The reactor area includes the following items of plant: fuel elements, mobile reflector, primary gas circuit, pressure vessel, charge/discharge machine, loading facility and fuel element storage and purging system, core bedplate, steel irradiation specimen, pressure vessel main shield plug, control rod mechanism, fuel element spike pocket, thermal column, nuclear detectors in the thermal column, thermal shield, biological shield, primary heat exchangers ventilation, primary gas circuit blower. (auth)

38481 (GA-8600) PUBLIC SERVICE COMPANY OF COLORADO 330-MW(e) HIGH-TEMPERATURE GAS-COOLED REACTOR RESEARCH AND DEVELOPMENT PROGRAM. Quarterly Progress Report for the Period Ending March 31, 1968. (Gulf General Atomic, Inc., San Diego, Calif.). 30 Apr 1968. Contract AT-(04-3)-633. 261p. Dep. CFSTI.

CONCRETES — properties for use in reactor vessels, measurement of creep and strength,
FISSION PRODUCTS — release from coated particle fuels, (E)
FORT ST. VRAIN POWER REACTOR, UNIT 1 — pressure vessel for, design and testing of prestressed concrete,
— pressure vessel for, testing of thermal barrier for prestressed concrete,
— coolant flow in core of, analysis of normal and emergency,
— fuel element cycle management development program for,

—physics parameters analysis for,
—fuel element design and testing for,
—fuels for, preparation and testing of coated particle,
—steam generators for, development and testing of,
—control rod drives for, testing of,
—coolant compressors for, testing of,
GRAPHITE—radiation effects on, fast neutron, (E)
—properties of binder and filler materials for coated particle fuel elements, (E)
NEUTRONS, FAST—effects on properties of graphite, (E)
—effects on coated particle reactor fuels, (E)
REACTOR FUELS—properties of beds of bonded coated particle type, (E)
THORIUM CARBIDES—ThC_2–UC_2, radiation effects on BISO and TRISO coated particles, fast neutron, (E)
URANIUM CARBIDES—ThC_2–UC_2, radiation effects on BISO and TRISO coated particles, fast neutron, (E) (D.C.C.)

38482 (NP–18112) REPORT AND ACCOUNTS OF THE UNITED KINGDOM ATOMIC ENERGY AUTHORITY FOR THE YEAR ENDED 31st MARCH 1969 TOGETHER WITH THE COMPTROLLER AND AUDITOR GENERAL'S REPORT ON THE ACCOUNTS. Fifteenth Annual Report. (United Kingdom Atomic Energy Authority, London (England)). 23 Jul 1969. 144p. Dep. CFSTI (U. S. Sales Only). UK 12s. 6d.

Finance, accounts, and contracts and the Trading Fund report are given. Also, a review of production factories and the Amersham Radiochemical Centre, the reactor program, nuclear fusion and plasma physics research, applied nuclear research and development, non-nuclear research and development, scientific and technical support, health and safety, international relations, and information services is presented. An illustrated summary is presented under separate cover. (W.H.K.)

38483 REQUIREMENTS AND PRODUCTION PROBLEMS WITH HTR GRAPHITE COMPONENTS. Kackstein, K. G. (Nuklear-Chemie und -Metallurgie GmbH, Wolfgang, Ger.); Semmler, G.; Vohler, O. Atomwirt., Atomtech.; 15: 276(Jun 1970). (In German).

For high temperature reactors graphite components must fulfill strict specifications because of their use as moderator, reflector, shielding material, and heat insulator. In addition to its origin, properties of graphite depend strongly on technological processing. Before manufacturing a component, numerous samples of the material must be destroyed and analyzed for inhomogeneities to assure specifications. (tr-auth)

38484 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Triggs, Geoffrey William; Prince, Norman (to United Kingdom Atomic Energy Authority). British Patent 1,196,322. 24 Jun 1970. Filed 9 Mar 1967.

Reference is made to neutron moderating reactor core structures. In gas-cooled graphite-moderated reactors the core structure comprises columns of graphite blocks keyed together, in such a way as to minimise movement of the blocks due to distortion while the reactor is operating. Disadvantages of conventional types of keys are enumerated. In the structure described at least some of the graphite columns have channels through the blocks arranged to provide continuous channels through the columns the distance between the centres of the blocks being held substantially constant by keys in keyways in the sides of the blocks. The keyways extend along the length of the blocks for a distance less than the length of the blocks, and a keyway in each block engages two or more complete keys in end to end abutment, each key cooperating with a keyway to key the block to a laterally adjoining block. Each key is thus of shorter length than the block and is less likely to break, as well as requiring less clearance. The keys are also not subjected to the large shearing force at the lower ends of the blocks. The sum of the keys embraced by any one keyway is preferably substantially less than the length of the keyway to accommodate differential shrinkage between adjoining columns. Each key may be integral with a side wall of a key assembly having keys projecting into keyways in more than two blocks, or each key may be located in oppositely facing keyways in two adjacent blocks, or both types of keys may be used in a core structure. The keyways may be formed as full length slots with fillers or spacers in the lower ends or as blind ended slots. Each slot may be end-milled in a block with a rounded end and the key nearest this end be cut away to prevent jamming, or be held clear of the rounded end by a spacer. (UK)

38485 NUCLEAR REACTORS. Shaw, Michael Kevin; Orszak, Peter (to English Electric Co. Ltd.). British Patent 1,196,915. 1 Jul 1970. Filed 9 Sep 1966.

Reference is made to reactors having a transverse dividing wall, including a membrane, within a pressure vessel. The dividing wall is attached to the pressure vessel so as to separate the interior space into two parts. Such an arrangement is used in reactors of the split-flow type (also known as "dual flow" or "re-entrant" type). In operation of a reactor of this type there is a pressure difference across the membrane and a temperature difference between the membrane and the pressure vessel wall, making the junction between the membrane and the pressure vessel liable to substantial relative movement. In addition radial and/or axial relative movement may occur, due to external forces, such as may result from prestressing forces in the concrete of the pressure vessel. Provision must thus be made for the membrane to expand and contract transversely while supporting the pressure differences across it and also maintaining a satisfactory seal with the pressure vessel wall. In the system described the pressure vessel has two spaces separated by a membrane with its edge sealed to the pressure vessel wall by a resilient seal which allows movement of the edge relative to the wall. This seal may be attached to a skirt extending around the pressure vessel wall. The skirt is preferably frusto-conical, although it may have any suitable cross-section, and it may also be resilient; it may be joined to the pressure vessel by a rigid ring attached to the pressure vessel wall. The membrane may have reinforcing castellations. Several alternative geometrical arrangements are described, together with various embodiments by way of example. (UK)

38486 SUPERCRITICAL HETEROGENEOUS NUCLEAR REACTOR OF THE PRESSURE VESSEL TYPE. Winkler, F.; Knodler, D.; Huber, G. Canadian Patent 841,850. 12 May 1970. Priority date 26 Aug 1965, Germany.

The core in a heterogeneous nuclear reactor of the pressure vessel type moderated and cooled by the same liquid at supercritical temperature and pressure consists of several fuel elements and super-heater elements. Included is a number of fuel rods in a lattice-like arrangement and a number of coolant separator tubes surrounding and spaced from the fuel rods. There is a flow path having portions extending sequentially intermediate to the coolant separator tubes. Through the interior of these tubes of the fuel elements along the fuel rods disposed therein and through the coolant separator tubes of the super-heater elements a common moderator and coolant liquid traverses the portions of the flow path extending intermediate to the coolant separator tubes and through the interior of the coolant separator tubes for the fuel elements. The liquid is vaporized in the coolant separator tubes by the heating action of the fuel rods within. The vaporized liquid traverses the portion of the flow path through the coolant separator tubes for the super-heater elements absorbing heat from the heating action of the fuel rods. (F.S.A.)

Kinetics and Dynamics

Refer also to abstracts 36862, 38436–38440, 38442–38445, 38619, and 38622.

38487 (DP-Report-60) STEWPOT: A 43-GROUP CODE FOR CALCULATION OF NEUTRON SPECTRA AND MULTI-GROUP CONSTANTS. Project DRAGON. Massimo, L.; Schroeder, E. (Atomic Energy Establishment, Winfrith (England)). Jan 1962. 19p. Dep. CFSTI.

The programme writes the 43-groups diffusion equations and solves them for a bare system after having found the corresponding buckling. (auth)

38488 (DP-Report-61) DETERMINATION OF THE FLUX DISTRIBUTION PRODUCED BY A SOURCE IN AN UNDERCRITICAL REACTOR. Project DRAGON. Massimo, L. (Atomic Energy Establishment, Winfrith (England)). Oct 1961. 10p. Dep. CFSTI.

For instrumentation purposes it is necessary to know the flux distribution produced by sources when the reactor is in a shutdown condition. The method of solution is based on an expansion of the flux in eigenfunctions throughout an axially reflected and radially bare reactor. (auth)

38489 (DP-Report-82) CALCULATIONS ON THE ZENITH REACTOR. Project DRAGON. Kalnaes, O. (Atomic Energy Establishment, Winfrith (England)). Jan 1962. 36p. Dep. CFSTI.

A brief description of the geometrical model assumed for the Zenith reactor and the different core compositions is presented. The main computer programmes used are also mentioned. The calculations of the resonance integral for the thorium pellets, of energy dependent disadvantage factors, of buckling, of reactivity, and of temperature coefficients are described. The calculated results are compared with experiments. (16 references) (auth)

38490 (DP-Report-135(Pt.2)) THE CIVIL H.T.R. REFERENCE DESIGN STUDY. Project DRAGON. Thorn, J. D. (ed.). (United Kingdom Atomic Energy Authority, Risley (England). Reactor Group). Jan 1963. 204p. Dep. CFSTI.

For Atomic Energy Establishment, Winfrith, Eng.

Physics parameters for the 1000 MW(e) reference design HTR are presented. Stresses in the graphite core sections are analyzed. Design requirements for the boilers are presented. Control systems are described. (D.C.C.)

38491 (DP-Report-135(Pt.3)) THE CIVIL H.T.R. REFERENCE DESIGN STUDY. Project DRAGON. Thorn, J. D. (ed.). (United Kingdom Atomic Energy Authority, Risley (England). Reactor Group). Jan 1963. 135p. Dep. CFSTI.

For Atomic Energy Establishment, Winfrith, Eng.

Physics calculations are presented for the 1000 MW(e) reference design HTR. The physics calculations include: core physics; fuel cycle; and control rod worths. (D.C.C.)

38492 (LA-4294) HYDRAULIC EFFECTS IN CIRCULATING FUEL REACTORS. Adler, Felix T. (Los Alamos Scientific Lab., N. Mex.). Jan 1970. Contract W-7405-eng-36. 31p. Dep. CFSTI.

The well-known results for the boundary layer flow in a pipe are reviewed with the aim of ascertaining the effects of the radial velocity distribution on the fuel exposure in a circulating fuel reactor. The laminar sublayer and the turbulent-laminar transition layer are of particular relevance for the fuel exposure because of the increased residence time of the fuel solution in these regions during core passage. The semiempirical approaches for the velocity distributions in these regions are reviewed in detail and are compared with available experimental data. The radial distribution of energy deposition in aqueous solutions of ^{235}U corresponding to those of interest for the Kinetic Intense Neutron Generator (KING) reactor and possible full-scale devices are considered and compared with existing data on the limits for safe exposure not leading to fuel decomposition. Although exposures in the KING dynamic experiments appear to be acceptable, full-scale devices may have excessive energy deposition rates in the boundary region. Conjectures are discussed as to methods to avoid any excess local energy deposition in full-scale devices. (49 references) (auth)

38493 AEG SUPERHEAT REACTOR EXPERIMENTS IN A CRITICAL FACILITY AND ZERO-POWER TESTS. Fischer, K.; Nitschke, R.; Andres, R. Atompraxis; 16: 174-8; 181-3(May-Jul 1970). (In German).

The AEG superheat reactor differs principally from normal boiling water reactors by its tube type fuel, which is cooled externally by boiling water and internally by steam. To test the nuclear design data of this new reactor type an intensive measuring program was performed in the critical facility in Groswelzheim and in the reactor at zero-power. (auth)

38494 EXPERIMENTAL COMPARISON BETWEEN IN-CORE GAMMA RADIATION AND NEUTRON FLUX DENSITY DISTRIBUTION IN A PRESSURIZED WATER REACTOR. Weiss, H. (Westinghouse Electric Corp., Pittsburgh). Atomkernenergie; 15: 249-54(1970).

The various sources of gamma radiation in the core of a pressurized water reactor and their relation to the thermal neutron flux and local power density are briefly discussed. The distribution of the gamma radiation in the core of the Connecticut Yankee Pressurized Water Reactor was measured with a moveable in-core ion chamber under steady state plant conditions. The close agreement between the gamma radiation and the thermal neutron flux distribution, measured at the same time, justifies the attempt to calculate the in-core power distribution, the axial peaking and power peaking factors utilizing gamma information instead of the neutron flux data which were normally used for this purpose. The factors which are also calculated in the conventional way are compared with those obtained from gamma data. While close agreement is found for the center region of the core, the deviations become larger at the core boundaries. 3 references. (auth)

38495 RANDOM NOISE TECHNIQUES IN NUCLEAR REACTOR SYSTEMS. Uhrig, Robert E. New York; Ronald Press Company (1970). 500p. $20.00. (TID-25447).

Information concerning random noise techniques in reactors is presented under the following subject headings: statistics for random noise analysis; neutron-counting techniques in nuclear reactor systems; basic relations of random noise theory; reactor noise theory; noise measurement techniques; noise instrumentation and measurement techniques; acquisition, transmission, and recording of data; pseudorandom noise techniques; digital processing of data; experimental noise measurements in nuclear reactor systems; and special noise techniques and applications in nuclear systems. (D.C.C.)

38496 REACTIVITY COEFFICIENTS IN LARGE FAST POWER REACTORS. Hummel, Harry H.; Okrent, David. Monograph Series on Nuclear Science and Technology. Hinsdale, Ill.; American Nuclear Society (1970). 393p. $18.40. (TID-25449).

Information concerning reactivity coefficients in large fast power reactors is presented under the following subject headings: nuclear data; heavy-element resonant cross section evaluation; evaluation of light-element and of heavy-element nonresonant group cross sections; Na-void effect; Doppler effect; motion of fuel and structure; time constants, transient heat transfer, and reactor stability; super-prompt-critical reactivity accidents; reactivity coefficients and accident analyses; and coolants other than Na. (D.C.C.)

38497 TIME DISCRETIZATION HYBRID MODEL FOR NUCLEAR REACTOR CORES SIMULATION. Di Bartolomeo, M. (CNEN, Casaccia, Italy); Mathis, A.; Melucci, G.; Turrini, E. pp 102-10 of Analog and Hybrid Computation Applied to Nuclear Energy. Brussels, Presses Academiques Europeennes (1969).

From International Symposium on Analogue and Hybrid Computation Applied to Nuclear Energy, Versailles, France. See CONF-680941.

A hybrid model, particularly suitable for fast reactor cores simulation, is described. The model considers several radial cells for the core channel. A continuous integration is made into the axial direction, being the time quantized; the quantization interval, that can be chosen in a large range, has been selected in order to obtain the best precision. This model provides a very accurate simulation of temperature distributions both radially and axially, though maintaining the possibility of operating in connection with a real-time analog model of the whole plant. (auth)

38498 FORMALISM FOR THE SIMULATION OF THE DYNAMICS OF A NUCLEAR POWER PLANT ON AN ANALOG COMPUTER. De Greef, F. (Nuclear Energy Centre, Mol, Belg.). pp 243-51 of Analog and Hybrid Computation Applied to Nuclear Energy. Brussels, Presses Academiques Europeennes (1969).

From International Symposium on Analogue and Hybrid Computation Applied to Nuclear Energy, Versailles, France. See CONF-680941.

The set-up of a formalism suited to the simulation of the dynamics of a nuclear power plant on an analog computer facility is given. The formalism was written for a PWR reactor power plant. The purpose was to have a mathematical tool for the interpretation of data obtained by several campaigns of dynamic experiments done on this type of reactor power plant. Notwithstanding that this formalism is written for a PWR plant, it can nevertheless be applied successfully with some adaptation to other types of reactor plants. The part of originality of the formalism is the description of a method to get from the general time-space heat diffusion partial differential equation simple transfer functions relating the distributed thermal and hydraulic characteristics of the plant. (auth)

Control Systems

Refer also to abstract 38490.

38499 (DP-Report-90) TESTS ON ABSORBER RODS CONTROL MECHANISM. Project DRAGON. Nectoux, P.; Last, J. R. (Atomic Energy Establishment, Winfrith (England)). May 1962. 130p. Dep. CFSTI.

Performance parameters are evaluated for control rod drives operating under normal and abnormal conditions. (auth)

38500 (DP-Report-145) DESIGN PRINCIPLES FOR CONTROL MECHANISMS. Project DRAGON. Dean, J. R.; Caldarola, L. (Atomic Energy Establishment, Winfrith (England)). Mar 1963. 45p. Dep. CFSTI.

Analysis of the principles underlying the functions of the control rod drive particularly the arrestor, show that the choice of flywheel inertia is primarily a compromise between rod drop time and compact spring stop design. The stepping motor must be adequate to drive the system with its inertia at the required speed. The loads in the wire rope and arrestor link may impose limits on accelerations. (auth)

38501 (ORNL-TM-2927) CONTROL STUDIES OF A 1000-Mw(e) MSBR. Sides, W. H. Jr. (Oak Ridge National Lab., Tenn.). 18 May 1970. 46p. Dep. CFSTI.

Preliminary studies of the dynamics and control of a 1000-MW(e), single-fluid MSBR were continued. An analog simulation of an expanded lumped-parameter model was used. Steam temperature

control was accomplished by varying the secondary-salt flow rate. Improved reactor temperature control was accomplished by applying the load demand signal directly to the reactor outlet temperature controller as well as to the steam generators. (auth)

38502 NUCLEAR REACTOR CONTROL APPARATUS. Takahashi, Y.; Takamatsu, S. Canadian Patent 843,049. 26 May 1970. Priority date 20 Aug 1965, Japan.

A system for controlling a nuclear reactor is described which consists of: (a) a low operating speed main digital computer for storing of predetermined operating procedures; (b) apparatus for measuring various output quantities from the nuclear reactor; (c) a satellite computer of relatively high operating speed with respect to the speed of the main computer connected to the measuring apparatus for continuously scanning the outputs of the measuring apparatus; (d) a control apparatus connected to the satellite computer for regulating the state of reaction in the nuclear reactor; (e) a control means connected between the main computer and the reactor control apparatus for controlling the nuclear reactor control apparatus according to the operating procedure being provided by the main computer. The system involving the satellite computer is also described. (F.S.A.)

38503 SAFETY CONTROL SYSTEM PARTICULARLY FOR A NUCLEAR REACTOR. (to Combustion Engineering Inc.). British Patent 1,197,528. 8 Jul 1970. Priority date 15 Sep 1967, United States.

REACTOR CONTROL SYSTEMS—design of safety systems with multiple sensors and redundant switching circuits (H.D.R.)

38504 REACTOR CONTROL AND INSTRUMENTATION. Atomwirt., Atomtech.; 15: 243-4(May 1970). (In German).

Various methods and experiences with control system instrumentation are discussed as developed in Great Britain, Sweden, Germany, Russia, Canada, and the United States. High reliability permitting nuclear plant control without delay and without interference as to safety requirements is the desired goal. With respect to process computers, unification and simplification of instruments are found important. (H.B.G.)

38505 NEUTRON, TEMPERATURE, AND GAMMA SENSORS FOR PRESSURIZED WATER REACTORS. Loving, J. J. (Westinghouse Nuclear Energy Systems, Pittsburgh, Pa.). Contract AT(30-1)-3269). IEEE (Inst. Elec. Electron. Eng.), Trans. Ind. Electron. Contr. Instr.; 17: 120-9(Apr 1970).

Commercial pressurized water reactors designed by Westinghouse NES employ neutron and temperature sensors extensively for neutron flux and temperature measurements in the reactor cores. These are for use in monitoring, control and protection of the reactor with some being located actually within the core and others external to the reactor vessel. The "evolution" of the functional requirements, development and application of these sensors, is described from the early applications in the Yankee (Rowe) and Belgian (BR-3) plants on through recent large plants such as Connecticut-Yankee and others under construction. The operational requirements determining the functional specifications and the reasons for types of sensors and physical locations selected are discussed. Development work required to improve on previous sensor designs is included. Gamma sensors have been used in an experimental manner leading to possible future power reactor application. Development work under way on these sensors is also discussed. 7 references. (auth)

38506 USE OF A HYBRID COMPUTER IN FEEDBACK CONTROLLER DESIGN. Love, Carl G. (Westinghouse Electric Corp., Pittsburgh). pp 252-8 of Analog and Hybrid Computation Applied to Nuclear Energy. Brussels, Presses Academiques Europeennes (1969).

From International Symposium on Analogue and Hybrid Computation Applied to Nuclear Energy, Versailles, France. See CONF-680941.

A method for designing feedback controllers which allows the designer to investigate several controller structures without performing lengthy computations is presented. The method requires the availability of the desired or optimal plant trajectory. Thus, the method may be viewed as a technique for arriving at practical feedback implementations of optimal open or closed loop input functions. The technique is applied to the design of a feedback for a pressurized water reactor. (auth)

38507 OPTIMAL CONTROL TRAJECTORIES BY QUASI-LINEAR PROGRAMMING ON A HYBRID COMPUTER. Enns, Mark (Carnegie-Mellon Univ., Pittsburgh). pp 259-63 of Analog and Hybrid Computation Applied to Nuclear Energy. Brussels, Presses Academiques Europeennes (1969).

From International Symposium on Analogue and Hybrid Computation Applied to Nuclear Energy, Versailles, France. See CONF-680941.

The computation of optimal trajectories for a high order dynamic system has been solved rather satisfactorily and in great generality for linear systems through the use of linear programming. The method is extended to compute by solving a sequence of linear programming problems, optimal trajectories for systems described by a set of nonlinear ordinary differential equations. The development is sufficiently general to permit use of an arbitrary number of state trajectory and control constraints (generally inequalities), terminal constraints, and a point or minimax objective function. This work was motivated by problems arising in the control of pressurized water reactor (PWR) nuclear reactor power plants. The models used for control studies of the PWR plants are of high order (20 to 30 differential equations), nonlinear and have several control inputs and variables which must be controlled. (auth)

38508 A NEW DIGITAL CONTROL ALGORITHM MAINLY BASED ON ON-LINE NOISE ANALYSIS IN NUCLEAR POWER REACTORS. Bliselius, P.-A. (Aktiebolaget Atomenergi, Studsvik, Sweden). pp 270-7 of Analog and Hybrid Computation Applied to Nuclear Energy. Brussels, Presses Academiques Europeennes (1969).

From International Symposium on Analogue and Hybrid Computation Applied to Nuclear Energy, Versailles, France. See CONF-680941.

In the design of control systems for nuclear power reactors (at least for boiling water reactors) it is necessary to take into account the influence of noisy error signals. As it would be very useful to know how large a noise amplitude a certain control system can tolerate, the noise-tolerant control system concept is introduced. Normally, the noise tolerance limit is set by that value, which exceeds the scram limit (e.g., 10% above the nuclear power). The noise tolerance cencept also ought to include a limit for the time during which the control reactivity rate is working in saturation. In this sense an ON/OFF system is basically more noise-tolerant than a continuous control system. The number of control actions per time unit during steady-state operation is suggested as a figure of merit for noise-tolerant control. The development of the DDC algorithm was carried out on a hybrid computer, PDP-8/TR-48. The theory and application of the algorithm are discussed. In the theoretical derivation gaussian distributed noise is assumed. The algorithm developed works provided that noise is present in the error signal. The DDC algorithm uses a new filtering technique based on the noise distribution function. The test results of the DDC application are coupled to parameters of the inherently unstable power reactor simulated. (auth)

38509 SIMULATION OF A DIGITAL CONTROL SCHEME ON A PARALLEL HYBRID COMPUTER. Bowyer, P. A.; Washby, V. pp 278-9 of Analog and Hybrid Computation Applied to Nuclear Energy. Brussels, Presses Academiques Europeennes (1969).

From International Symposium on Analogue and Hybrid Computation Applied to Nuclear Energy, Versailles, France. See CONF-680941.

A simple point model reactor was simulated on a PACE 231-R analogue computer. The system was set up in a steady state condition for nominal maximum power and coolant flow. A three-term controller was simulated and used to control the coolant outlet temperature, by changing reactivity. (auth)

38510 HYBRID COMPUTER STUDY OF DIRECT DIGITAL CONTROL OF A NUCLEAR POWER STATION. Davis, D.; Darker, H. A. (Nuclear Design and Construction Ltd., Leicester, Eng.). pp 280-300 of Analog and Hybrid Computation Applied to Nuclear Energy. Brussels, Presses Academiques Europeennes (1969).

From International Symposium on Analogue and Hybrid Computation Applied to Nuclear Energy, Versailles, France. See CONF-680941.

The model and techniques adopted in the simulation of the direct digital control of a nuclear power station on the N.D.C. Saturn analogue computer and the results of the investigation are described. A description of the Saturn computer is given. The model consists of a non-linear reactor, once through boiler, turbine and steam driven feed pump and is programmed for three of the computers using some 700 amplifiers together with non-linear equipment such as multipliers and functions of two variables. The digital control systems are simulated using the hybrid computing facility. The object of the investigation is to demonstrate the feasibility of direct digital control of a nuclear power station and to examine the performance of the overall station control scheme during normal operation of the station and under certain fault conditions. (auth)

Shielding

38511 (AI-AEC-Memo-12708(SuppLA)) PNPF RETIREMENT SAFETY ANALYSIS REEVALUATION OF RESIDUAL NUCLIDES.

Hewson, R. A. (Atomics International, Canoga Park, Calif.). 15 Jan 1969. Contract AT(04-3)-701. 49p. Dep. CFSTI.

Subsequent to the completion of the Piqua Nuclear Power Facility Retirement Safety Analysis Report, analyses of samples of concrete from the reactor biological shield were completed. These analyses indicated that the neutron flux levels were significantly lower than those calculated during the design of the reactor and used for the determination of radioactivity content of the shield concrete. Also, the chemical and radiochemical analyses showed different, and in some cases higher, concentrations of some trace elements which are precursors of radioisotopes of potential concern. Accordingly the neutron flux levels were recalculated using present day shielding analyses techniques and cross section data. The ANISN code was used to perform 20 group transport calculations with S8 quadrature coefficients and anisotropic scattering in the P-3 approximation. The neutron flux levels from these calculations were in good agreement with the results from the shield sample analyses. These results, adjusted to a slightly higher than calculated flux level to assure a conservative result, were used to reanalyze the radioisotopic sources to be left at the PNPF site. From the reanalysis it was concluded that the source levels were either the same or lower than those previously predicted. (13 references) (auth)

Cooling Systems

Refer also to abstracts 36482, 36665, 38490, and 38590.

38512 (AI-AEC-12914) AEC UNCLASSIFIED PROGRAMS QUARTERLY TECHNICAL PROGRESS REPORT, OCTOBER–DECEMBER 1969. (Atomics International, Canoga Park, Calif.). 15 Feb 1970. Contract AT(04-3)-701. 47p. Dep. CFSTI.

CHROMOSOMES—radiation chemistry of mammalian, (E)
HALLAM POWER REACTOR—retirement activities during October to December 1969
LIQUID METAL FAST BREEDER REACTOR—cooling system for, sodium superheating behavior in, (E)
NICKEL—radiation effects on void formation in, proton, (E)
PROTONS—effects on void formation in nickel (E)
SODIUM—boiling heat transfer characteristics in reactor coolant channels, (E)
SUPERCONDUCTORS—thermodynamic and transport properties of, (E/T)
WATER—preparation of polywater (H.D.R.)

38513 (ANL-7670) MATERIALS-COOLANT INTERACTIONS IN EBR-II. Ruther, W. E.; Claar, T. D.; Greenberg, S.; Strain, R. V. (Argonne National Lab., Ill.). Mar 1970. Contract W-31-109-eng-38. 47p. Dep. CFSTI.

Of the many materials deliberately exposed to the EBR-II sodium coolant, only copper, beryllium copper, and tantalum experienced an undesirable direct reaction. Failures of thin sections of normally resistant metals (Types 304, 347, and 420 stainless steels and Inconel) were related to the presence of a contaminant (carbonaceous material or oxide) on the surface before insertion into the reactor sodium. Components removed from the reactor after long exposures showed only minor dissolution attack. The attack was greater with increasing temperature; however, radiation did not cause a detectable increase in the attack. Carbon transport among steels of differing carbon activity was inconsequential. Quantitative corrosion evaluations of vanadium alloys, stainless steels, nickel, and nickel-base alloys in the reactor coolant showed rapid corrosive attack only for unalloyed vanadium. (17 references) (auth)

38514 (ANL-Trans-839) ANALYSIS OF THE INFLUENCE OF THE "DOWN-STREAM" EFFECT ON THE RESULTS OF SODIUM CORROSION TESTS AND THEIR USEFULNESS FOR REACTOR DESIGN. Borgstedt, H. U.; Frees, G.; Drechsler, G. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Material- und Festkoerperforschung). Translated for Argonne National Lab., Ill., from report KFK-1061. 13p. Dep. CFSTI.

The downstream effect in liquid sodium corrosion of stainless steels is normally described as an effect of the saturation of liquid sodium with corrosion products. Using the results of corrosion tests the increase in concentration of iron in sodium passing the hot parts of the systems was calculated. The results are compared with the saturation concentrations of iron in liquid sodium. There is no significant raise of the iron concentration in the high temperature sections of the loops. Therefore, the downstream effect cannot be due to the sodium saturation. The test results are free from any saturation influence and from systematic errors due to such an effect. Therefore, the measured corrosion rates can be used for reactor calculation. The downstream effect may be caused by inconstant conditions in the test sections of the corrosion loops. (auth)

38515 (APDA-256) PRELIMINARY STUDY OF FEASIBILITY OF ACOUSTIC DETECTION OF SMALL SODIUM–WATER REACTIONS IN LMFBR STEAM GENERATORS. Barkhoudarian, S.; Scott, C. C. (Atomic Power Development Associates, Inc., Detroit, Mich.). May 1970. Contract AT(11-1)-865. 79p. Dep. CFSTI.

An evaluation of acoustic techniques for the detection of sound resulting from water leaks into liquid Na is conducted. Acoustic spectra over the range of 100 Hz to 80 kHz are detected. A leak as small as 0.00008 lb/sec is detected by the acoustic instrumentation. Since this is the smallest leak rate used in the tests, it is not to be interpreted as the smallest leak rate that might be detected by acoustic methods. Detection time is found to be essentially instantaneous. 11 references. (auth)

38516 (DP-Report-33) HIGH TEMPERATURE ANNULUS RIG EXPERIMENT. Project DRAGON. Alami, R.; Butcher, A. A. (Atomic Energy Establishment, Winfrith (England)). May 1961. 38p. (NP-10433). Dep. CFSTI.

An experiment to examine the effect of high surface temperatures (1300°K) on heat transfer in annuli is described. Correlations are developed for overall heat transfer coefficient, local heat transfer coefficient, friction factor, velocity and temperature distributions. 14 references. (auth)

38517 (DP-Report-33(Rev.)) HIGH TEMPERATURE ANNULUS RIG EXPERIMENT. Project DRAGON. Alami, R.; Butcher, A. A. (Atomic Energy Establishment, Winfrith (England)). May 1961. 39p. Dep. CFSTI.

An experiment to examine the effect of high surface temperatures (1300°K) on heat transfer in annuli is described. Correlations are developed for overall heat transfer coefficient, local heat transfer coefficient, friction factor, velocity and temperature distributions. 14 references. (auth)

38518 (DP-Report-66) LEAK TESTING OF THE TEST VESSEL AND EXPERIMENTAL GASKETS AT MANNESMANN, HUCKINGEN, WEST GERMANY. PART 3. Final Report. Project DRAGON. Barnes, D.; Wade, F. (Atomic Energy Establishment, Winfrith (England)). Nov 1961. 17p. Dep. CFSTI.

Parts 1 and 2 issued as DP-Reports-23 and -24, respectively.

The results of leak tests carried out on seal welding features of the pressure vessel are presented. (auth)

38519 (DP-Report-96) THE WATER FLOW VISUALISATION RIG. RESULTS OBTAINED ON THE REACTOR CHANNEL. Project DRAGON. Hansen, K. (Atomic Energy Establishment, Winfrith (England)). May 1962. 17p. Dep. CFSTI.

A water flow visualisation rig is described. The results of experiments on a scaled-up model of the Dragon coolant channel are presented. The various techniques of flow visualisation are described. (auth)

38520 (DP-Report-110) TEMPERATURES IN DRAGON: A PROGRAMME FOR THE FERRANTI MERCURY COMPUTER. Project DRAGON. Zanantoni, C. (Atomic Energy Establishment, Winfrith (England)). Mar 1963. 56p. Dep. CFSTI.

The programme described calculates: coolant flow distribution; coolant and fuel element temperatures in the Dragon core; and temperature distribution in the reflector for the Dragon reactor. (auth)

38521 (DP-Report-121) PRELIMINARY REPORT ON THE SAFETY ASPECTS OF PRESSURE RELIEF OF THE SECONDARY CIRCUIT IN THE HEAT DISPOSAL SYSTEM. Project DRAGON. Coudray, M. A. (Atomic Energy Establishment, Winfrith (England)). Nov 1962. 64p. Dep. CFSTI.

Special problems were encountered in the design of the Dragon Reactor Secondary Circuit. To a certain extent, it is considered that these problems, and the particular solutions which they call for, are not specific to Dragon but will arise with high temperature gas-cooled, graphite moderated reactors. In such reactors, the secondary circuit appears as a secondary containment for the radioactive primary fluid and, consequently, the discharge of the safety valves (or the dump condenser, in a power producing reactor) must be positively separated from the atmosphere. The solution to this problem in the case of the Dragon Reactor is described. (auth)

38522 (DP-Report-154) LEAK TESTING THE DRAGON REACTOR PRESSURE VESSEL. Project DRAGON. Barnes, D.; Wade, F. (Atomic Energy Establishment, Winfrith (England)). Jan 1963. 24p. Dep. CFSTI.

Details are presented of test procedures and results obtained on leak tests carried out at the manufacturers' works under typical

boiler-shop conditions and at the reactor site during the construction period. (auth)

38523 (DP-Report-200) SURVEY OF IMPORTANT DESIGN PARAMETERS FOR THE DRAGON HEAT DISPOSAL CIRCUITS. Project DRAGON. Tweedy, C. H. (Atomic Energy Establishment, Winfrith (England)). Jul 1963. 40p. Dep. CFSTI.

The many detailed calculations carried out for both conventional and unconventional items of plant and circuit during the design of the Dragon reactor heat disposal system are summarised. The special problems presented by the system are studied in detail. (6 references) (auth)

38524 (KFK-1042) LOCAL TEMPERATURES IN SODIUM-COOLED ROD BUNDLES CALCULATED WITH THE HELP OF A DIGITAL PROGRAM. PART I. INFLUENCE OF THE HOUSING WALL OF THE FUEL ELEMENT. Baumann, W. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Reaktorbauelemente). Sep 1969. 28p. (In German). Dep. CFSTI (U. S. Sales Only).

The coolant temperatures in the subchannels of rod bundles with axial flow are calculated. The calculation method developed considers the radial expansion and the energy exchange between neighboring subchannels. The radial temperature distribution in the 19- and 61-rod bundles with spaced lattice containers is discussed. All bundles are in a hexagon guide tube and are heated equally over the cross section. The calculation shows that in the rhombus lattice and in a spiral wire the coolant temperatures in the central channel are considerably over the average temperature and those in the exterior channel are considerably under. In the beveled honeycomb lattice and in 3- and 6-fin bundles temperature profiles are obtained which deviate only slightly from the average temperature. With increasing rod number the temperature of the hot inner channel approached the average value, whereas the deviation of the cold wall channels was increased. The pressure loss in the 3 and 6 spiral fins or in 1 spiral wire reached only half of the pressure loss occurring in spaced lattices. (tr-auth)

38525 (ZJE-68) EXPERIMENTAL GAS LOOP. Martinek, Jan; Novotny, Karel (Skoda Concern, Pilsen (Czechoslovakia). Nuclear Power Plants Div.). 1970. 24p. Dep. CFSTI (U. S. Sales Only).

The design of an experimental loop and the experience gained in the putting of it into operation are described. It contains a summary of the technical parameters of the individual technological components of the loop and a description of the modes of operation of its individual circuits and deals with the possibilities of utilization of existing equipment for experiments demanding a source of gas under pressure and with a perspective extension of the experimental base in future years. (auth)

38526 EXPERIENCES WITH THE PRODUCTION OF REACTOR PRESSURE VESSELS. Ulrich, W. (AEG-Telefunken, Frankfurt am Main). Atomwirt., Atomtech.; 15: 280-2(Jun 1970). (In German).

Construction of the pressure vessel for the reactor Wuergassen was delayed because of deficiency in welding, defects in the chromium plating of the inner surface requiring a second coat, and failure to obtain a leakproof welding of the pump connection. In addition, poor planning and transportation problems contributed to the delay. It was concluded that the problems were not specific for reactor vessels. Organization of labor must be planned exactly. Test specifications must be clearly defined. In the meantime, through proper planning, several additional vessels were completed within 12 to 24 months. (H.B.G.)

38527 IN-SERVICE INSPECTION OF NUCLEAR REACTOR VESSELS USING AN AUTOMATED ULTRASONIC METHOD. Gross, L. B.; Johnson, C. R. (Babcock and Wilcox, Lynchburg, Va.). Mater. Eval.; 28: 162-7(Jul 1970).

A dual-probe, send-and-receive ultrasonic method for remote, on-site nondestructive inspection of the cylindrical region of nuclear reactor vessels was devised and demonstrated. The probes were moved about the vessel on a rigid, preprogrammed transporter. The resultant inspection records for initial and subsequent examinations could be compared by a computer to indicate the initiation or propagation of defects and to characterize the location, orientation and size of the defect. (auth)

38528 METHOD FOR ADJUSTING THE GAS FLOW-RATE THROUGH THE CHANNELS OF A NUCLEAR REACTOR. (to Commissariat a l'Energie Atomique). British Patent 1,198,006. 8 Jul 1970. Priority date 5 Jun 1967, France.

REACTORS, GAS-COOLED—coolant channels of, design of gas flow regulation for (D.C.C.)

38529 EFFECTS OF PUMP PERTURBATIONS ON THE COOLING OF THE CORE AND THE LAY-OUT OF THE CIRCUIT OF HIGH PERFORMANCE FAST BREEDER. Scharfe, A. (AEG Kernenergieanlage, Grosswelzheim, Ger.). Atompraxis; 16: 159-62; 65(May-Jul 1970). (In German).

For the appropriate lay-out of the primary circuit of the High-Performance Fast Breeder—1000 MW(e) Sodium Cooled Fast Breeder Reactor—the question of the effects of pump perturbations on the primary circuit and on the cooling of the core were examined. The criteria to be used for the lay-out of the circuit are indicated. The possible perturbations can be governed by taking these criteria into consideration and by control measures, without reaching inadmissible loads in the circuit or too high temperatures in the core. (auth)

38530 EXPERIENCE IN DESIGN, CONSTRUCTION, AND OPERATION OF APPARATUSES OF THE HELIUM PURIFICATION SYSTEM OF A HIGH-TEMPERATURE REACTOR. Koellner, P. (Linde AG, Munich). Atompraxis; 16: 165-9(May-Jul 1970). (In German).

The design of parts of apparatus of helium purification plant and relevant construction and operation are described. To begin with, the fundamental instructions are given and explained in a brief survey. The essential instructions concern requirements with regard to sealing gas spaces and sealing gas systems, requirements with regard to space restriction for the dimensioning of apparatus, with regard to the reduction of the disintegration energy and to remote control, conditions with regard to material stresses and prevention of corrosion, as well as conditions with regard to tightness of the apparatus and valves and fittings. There are indicated the design measures which have been taken in order to meet all requirements and conditions. There are shown representations referring to the text, such as the solution for a compact type of construction which comes up to process requirements, with grouping of the heat exchangers, separators and adsorbers, arrangement of valves and fittings and installation of pipe elements, and technical solutions for insulations. Manufacturing problems are also dealt with. Finally, operating experience with regard to the particularities of the purification system is given. (auth)

38531 SPATIAL TEMPERATURE FIELD IN THE WALLS OF A PRE-STRESSED CONCRETE REACTOR VESSEL. Zdravkovic, M. M. (Univ., Belgrade. Energoproject, Belgrade); Vlajic, M. Z. Atomkernenergie; 16: 11-18(1970).

The digital computer technique was used to determine the temperature field in the concrete reactor vessel. The spatial distribution of the heat generation was applied with two rows of cooling pipes inside the walls. The obtained temperature field showed five characteristic regions which are discussed in detail. The variation of the following parameters was performed: the inlet coolant temperature, the flow direction of the coolant in the pipes, the over-all increase in coolant temperature, the nuclear heat generation and influence of the pipe penetration in the lower dome. 8 references. (auth)

38532 LIQUID METAL COOLING SYSTEM. Van Andel, Eleonoor (to European Atomic Energy Community). British Patent 1,198,910. 15 Jul 1970. Priority date 16 Jun 1967, Germany.

REACTORS, LIQUID METAL-COOLED—cooling system for, design of variable pressure two-phase (D.C.C.)

38533 HYBRID SOLUTION OF PARTIAL DIFFERENTIAL EQUATIONS OF THE HYPERBOLIC TYPE AND MULTIPURPOSE HYBRID COMPUTING CENTER AT THE INSTITUT FUER MESS- UND REGELUNGSTECHNIK. Neuenhahn, P.; Hoermann, H. (Technische Hochschule, Munich). pp 176-82 of Analog and Hybrid Computation Applied to Nuclear Energy. Brussels, Presses Academiques Europeennes (1969).

From International Symposium on Analogue and Hybrid Computation Applied to Nuclear Energy, Versailles, France. See CONF-680941.

The hybrid computer simulation of the two-phase flow of a heated channel during reactor depressurization transients is described. The coolant channel is simulated by a homogeneous model using partial differential equations of the hyperbolic type. The three computer hybrid system used for the coolant channel studies is described. (H.D.R.)

38534 HYBRID SIMULATION OF NUCLEAR POWER PLANT HEAT EXCHANGERS WITH FORCED CIRCULATION. Perrin, M.; Marsot, G. (Electricite de France, Paris). pp 191-4 of Analog and Hybrid Computation Applied to Nuclear Energy. Brussels, Presses Academiques Europeennes (1969). (In French).

From International Symposium on Analogue and Hybrid Computation Applied to Nuclear Energy, Versailles, France. See CONF-680941.

A method is described for the hybrid computer simulation of a heat exchanger, isolated from the system, but presenting the conditions at the limits encountered in the complete system. (H.D.R.)

38535 HYBRID STOCHASTIC MONTE CARLO METHODS FOR SOLVING HEAT TRANSFER PROBLEMS IN NUCLEAR REACTORS. Cimorelli, L. (CNEN, Rome); Caporaso, R.; Federico, A. pp 195-205 of Analog and Hybrid Computation Applied to Nuclear Energy. Brussels, Presses Academiques Europeennes (1969).

From International Symposium on Analogue and Hybrid Computation Applied to Nuclear Energy, Versailles, France. See CONF-680941.

A review of the Monte Carlo method, in order to resolve partial differential equations using hybrid computers, is presented. Classes of problems are discussed. An outline of the computation is presented, for solutions of actual problems, involving analysis of thermal stress distributions in complex structures of a steam generator for fast nuclear reactors. (25 references) (auth)

38536 HYBRID SIMULATION OF A SODIUM HEATED ONCE-THROUGH STEAM GENERATOR. Hermelink, M. J. M. (N. V. Neratoom, Den Haag, Netherlands). pp 206-13 of Analog and Hybrid Computation Applied to Nuclear Energy. Brussels, Presses Academiques Europeennes (1969).

From International Symposium on Analogue and Hybrid Computation Applied to Nuclear Energy, Versailles, France. See CONF-680941.

The steam generator is a Na–H_2O counterflow heat exchanger. The sodium flows in parallel through the superheater and reheater, is then mixed and flows through the evaporator. The dynamic model given is based on the scheme that the sodium system is simulated in an open loop and that the water-steam loop is mainly closed. (auth)

Fuels

Refer also to abstracts 36153, 36170, 36204–36206, 36355, 38491, and 38595.

38537 (DP-Report-93) FUEL ELEMENT DEVELOPMENT: FISSION PRODUCT EMITTING FUEL. Project DRAGON. Gough, J. R. C. (Atomic Energy Establishment, Winfrith (England)). May 1962. 78p. Dep. CFSTI.

Fuel inserts of the "conventional" type are made incorporating special features, e.g. rounded corners as required in the case of a fuel box of high bursting pressure; and a longitudinal slot to improve contact across the fuel insert/fuel box interface under reactor operating conditions. A close study is made of the effect of the fabrication variables on fuel insert dimensions and porosity. Measurements are made of the dimensional changes of this type of fuel insert as a result of heat treatment, and the results are assessed in relation to the fuel box. Joints of low permeability are prepared by sealing fuel boxes with carbon resin cement. It was not possible to obtain joints of sufficiently low permeability by purely mechanical sealing. The "delay time" associated with a fuel box of low permeability is found to vary linearly with pressure. Pressure transients which would occur within the fuel box as a result of accidental loss of coolant pressure are found to be acceptable in the case of the fuel box with a fine hole. Conditions are established for the welding together of the inner and outer stainless steel cone assemblies of the fuel element. Techniques are developed for incorporating thermocouples into the fuel rod assembly. Following assembly trials, a particular design of fission product trap was selected for incorporation within the fuel tube end plug. (auth)

38538 (DP-Report-97) DIMENSIONAL BEHAVIOUR OF CONVENTIONAL DRAGON FUEL INSERTS. Project DRAGON. Redding, G. B. (Atomic Energy Establishment, Winfrith (England)). May 1962. 17p. Dep. CFSTI.

The dimensional behaviour of the "Conventional" Dragon fuel insert has been studied by room temperature measurements after heat treatments, and by continuous dilatometry. From these results it is possible to calculate manufacturing dimensions for the assembly process. (auth)

38539 (DP-Report-135(Pt.4)) THE CIVIL H.T.R. REFERENCE DESIGN STUDY. Project DRAGON. Thorn, J. D. (ed.). (United Kingdom Atomic Energy Authority, Risley (England). Reactor Group). Jul 1963. 55p. Dep. CFSTI.

For Atomic Energy Establishment, Winfrith, Eng.

Fuel cycle parameters for the 1000 MW(e) HTR reference design are analyzed. (D.C.C.)

38540 (DP-Report-188) EXPERIMENTS ON LEAK RATE AND BACK DIFFUSION CHARACTERISTICS OF THE FUEL ELEMENT. Project DRAGON. Good, P. D. (Atomic Energy Establishment, Winfrith (England)). Apr 1963. 30p. Dep. CFSTI.

Leak rate and back diffusion measurements on the joints at the lower end of the fuel element are described. The greatest source of leakage is shown to be the butt joint between the fuel tube and end plug, also the dimensional accuracy and smoothness of the purge hole in the end plug is of the utmost importance. (auth)

38541 (EIR-182) LONG-TIME RELATION OF THERMAL REACTOR WITH PARALLEL AND CROSSED ARRANGEMENTS OF FUEL ELEMENTS. Brunner, J. (Eidgenoessisches Institut fuer Reaktorforschung, Wuerenlingen (Switzerland)). May 1970. 83p. (In German). Dep. CFSTI (U. S. Sales Only).

The possibility of reducing the energy production costs by a uniform stress of the fuel elements in a thermal reactor with a crossed arrangement of the coolant channels is investigated. The studies are limited to systems with a single type of fuel element. In connection with the heat removal from the biaxial systems, the problems of the optimum carrying out of the two-material process are studied and several reactor variants are investigated by means of approximation calculations. Construction questions are not considered. A comparison of the burnup is made between the cross-lattice concept and cylinder reactors. 50 references. (J.S.R.)

38542 (EURFNR-722) CARBIDE FUELS FOR FAST BREEDER REACTORS. Kummerer, K.; Thuemmler, F. (comps.) (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Material- und Festkoerperforschung). Translation of report KFK-1111. 492p. Dep. CFSTI.

Work Performed under United States–Euratom Fast Reactor Exchange Program.

A comprehensive view of the present knowledge and experience on these fuels is presented. Seventeen contributions to the seminar are compiled in an elaborated and supplemented form. They are self-contained. The most essential results of the discussions are added to every single report. Beginning with the significance of these fuels for the application in fast breeders and the corresponding points of view in terms of reactor physics and economics, the series of subjects cover the important physical and chemical properties, the irradiation behavior, and the fabrication and reprocessing methods within the fuel cycle. A conclusive evaluation of the present status of knowledge is made. In this context, the most important goals of future practical development are also characterized. (auth)

38543 (JUL-639-RG) EXPERIMENTAL DETERMINATION OF RADIAL CONCENTRATION PROFILE OF SOLID FISSION PRODUCTS AND HEAVY METALS IN THE JACKETS OF SPHERICAL FUEL PARTICLES FOR HIGH-TEMPERATURE REACTORS. Baurmann, Karl Wilhelm (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorentwicklung). Feb 1970. 162p. (In German). Dep. CFSTI (U. S. Sales Only).

Studies were made on the transport of solid fission products and of U, Th, and Pa within the coating of coated fuel particles with the coating consisting of pyrolytic carbon. An essential principle of the research program was the development of a suitable chemical etching process for the homogeneous removal of the fuel element coating so that the determination of radial concentration profile of individual nuclides could be made on a single particle or on larger particle masses up to a total weight of 1 g. The determination of the particle dimension was done microscopically and by a computer program which considers essentially the weight loss occurring in the etching and depends on a model representation describing the etching process. The isotopes found in the etching solution were measured with a γ spectrometer in combination with a lithium-drifted germanium detector. In the temperature range from 1250 to 1700°C radial distribution profiles of the isotopes ^{235}U, ^{232}Th, ^{233}Pa, ^{95}Zr, ^{103}Ru, ^{140}Pa, ^{134}Cs, ^{137}Cs, ^{141}Ce, ^{144}Ce, and ^{131}I in the coating of fuel element particles of UO_2, $ThO_2(U,Th)O_2$, and $(U,Th)C_2$ were measured in a specially constructed high temperature vacuum furnace. The results were graphically represented. The escape factors were calculated in combination with a numerical method describing the transport process. (J.S.R.)

38544 (JUL-645-RG) FUEL CYCLE OF A 600 MW(e) TWO-ZONE PEBBLE BED CORE WITH REFLECTOR CONTROL. Bock, Hans Juergen (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorentwicklung). Mar 1970. 101p. (In German). Dep. CFSTI (U. S. Sales Only).

A burnup program is developed for a two-zone pebble bed core with reflector control which satisfies the specifications of the pebble-bed core. A fuel cycle is sought which provides homogeneous temperature profiles for all operational states. The calculation model and the program development are outlined. The design of the 600 MW(e) two-zone core is given based on the model development. It is shown that reflector control causes a series of problems. A very good solution appears to be a combination of core and reflector control. (J.S.R.)

38545 (KFK-1038) EXPERIMENTAL DETERMINATION OF THE PRESSURE LOSS IN A 37 ROD BUNDLE OF TUBES WITH 6 INTEGRAL SPIRAL RIBS PER ROD AS SPACERS. Tschoeke, H. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Reaktorbauelemente). Feb 1970. 31p. (In German). Dep. CFSTI (U. S. Sales Only).

For the economic design of a fuel element its total coolant pressure losses must be known. The losses consist of inlet, bundle, and outlet pressure losses. These are experimentally determined on a 37-rod bundle of cladding tubes with 6 integral spiral ribs. The studies are made in air, and the Reynolds range was $2 \times 10^4 < Re < 10^5$. The pressure loss results in the bundle can be represented by the relation $\lambda = 0.19 \times Re^{-0.21}$. The resistance coefficients for the inlet (ζ_E) and the outlet (ζ_A) are practically independent of the Reynold's number. The measurement results for the bundle inlet $\zeta_E = 0.4$ indicate that 40% of the pressure head in the bundle inlet are necessary supplementary to the acceleration pressure loss in order to form the inlet pressure difference. The outlet coefficient $\zeta_A = 0.5$ indicates that 50% of the pressure head in the bundle end must be withdrawn from the loss-free pressure gain in order to build the outlet pressure difference. The surface ratio F_H/F_S studied at the outlet is of some importance. If the cross section in the outlet channel is increased 5 times of the single free bundle cross section, the resistance coefficients are reduced about 20%. On an example calculated from the experimental results, it is shown that about 10% of the total pressure loss of the bundle occurs by inlet and outlet losses. 5 references. (tr-auth)

38546 IMPROVEMENTS IN AND RELATING TO NUCLEAR FUEL ELEMENTS. Bogdanovitch, Michel; Cauvin, Jean-Claude; Dieumegard, Max (to Commissariat a l'Energie Atomique). British Patent 1,197,880. 8 Jul 1970. Priority date 3 Jul 1968, France.

REACTOR FUEL ELEMENTS—design parameters of
REACTORS, FAST—fuel elements for liquid sodium cooled, design of fission gas vented
REACTORS, LIQUID METAL-COOLED—fuel elements for fast, design of fission gas vented (D.C.C.)

38547 REACTOR STRATEGIES. Margen, P. H. (Aktiebolaget Atomenergi, Sweden). Energy Int.; 7: No. 3, 18-23 (Mar 1970).

Calculational methods are analyzed for the design criteria of power reactors with optimum economic fuel cycles. 8 references. (D.C.C.)

38548 CONTINUOUS FUEL CHANGE UNDER LOAD-EFFECTS ON OPERATION AND FUEL CYCLE OF THE ADVANCED GAS COOLED REACTOR. Burton, R.; Kremer, E. BBC-Nachr.; 51: 466-9(Aug 1969).

In the AGR the fuel can be changed continuously under load giving improved availability, higher power factors and lower fuel cycle costs. The time sequence of the change processes and their effect on the reactor are discussed, such as the effect on power distribution in the core since excessive temperatures must be avoided. The use of absorber rods to balance power distribution and other methods are explained. The state of burnups in stable conditions and the initial phase are described. (Fuel Abstr.)

38549 DETERMINATION OF THE RATE OF BURNUP OF FUEL RODS BY GAMMA SPECTROMETRY. Schaechter, L.; Popa, P. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys.; 14: 1237-43(1969). (In French).

The axial distribution of the burnup on a fuel rod containing 10% enriched U was determined by the measurement of the absolute γ activity of ^{144}Ce. The relative distribution of ^{137}Cs and its migration along the axis of the rod was also established. A γ spectrometry installation with NaI crystal was used for the measurements of activity. (tr-auth)

38550 MECHANICAL AND THERMAL ANALYSIS OF CYLINDRICAL FUEL ELEMENTS DURING OFF-NORMAL CONDITIONS AFTER EXTENDED BURNUP. Bump, T. R. (Argonne National Lab., Ill.). Nucl. Appl. Technol.; 9: 301-8(Sep 1970).

The SWELL fuel-element-lifetime code employs the "cumulative-damage" approach to estimate when the cladding of an LMFBR mixed-oxide fuel element is likely to fail under normal and off-normal conditions. In the estimating process, properties and behavior of irradiated, as well as of unirradiated, cladding are considered. A unique feature of SWELL is its use of an empirical function, developed by calibration with experimental data, that relates the pressure-exerted-on-cladding-by-fuel-swelling to the pressure-of-fission-gas-retained-in-fuel. SWELL predicts that the lifetimes of some typical fuel elements will have to be reduced significantly, if the elements are to be expected to withstand rather modest off-normal conditions near end of life. However, there are reasons why the predictions may be overly pessimistic. Early results from the newer, and more-detailed, LIFE fuel-element-behavior code indicate that the accuracy with which a fuel element's operating history is followed may be important for gaining understanding of the element's behavior. To conserve computer time, the best way to simulate actual history, as far as cladding $\Delta D/D$ predictions are concerned, appears to be to use time-averaged power (excluding downtime) for a length of time sufficient to produce the actual burnup, which happens to be the SWELL practice. 25 references. (auth)

38551 EVALUATION OF A MODEL FOR PREDICTING FAST-REACTOR FUEL-PIN DEFORMATIONS. Merckx, K. R. (Battelle Memorial Inst., Richland, Wash.). Nucl. Appl. Technol.; 9: 309-16(Sep 1970).

A computer program was developed and used to validate and adjust models for predicting fuel pin deformations. An existing computer program, DEFORM, was combined with a clad swelling model to be a subroutine for calculating fuel pin deformations. Predictions of deformations made with this subroutine are compared with measured deformations in a parameter fitting program, SIMPLEX. A comparison of analyses made with this program, using input data collected from experiments on four irradiated fuel pins, indicated that the program version assuming only a clad swelling model predicted the mean deformations of these pins better than the program version assuming both clad swelling and a mechanical interaction between the fuel material and the clad material. 9 references. (auth)

38552 PERFORMANCE ANALYSIS OF A MIXED-OXIDE LMFBR FUEL PIN. Cox, C. M.; Homan, F. J. (Oak Ridge National Lab., Tenn.). Nucl. Appl. Technol.; 9: 317-25(Sep 1970).

Preliminary models for fuel and cladding performance are described and their predicted behavior compared with experimental data. These models are then applied in a performance analysis of a typical stainless steel clad-mixed oxide fuel pin. The results of the analysis indicate that any problems associated with fuel swelling or fuel-cladding interaction for this pin are swamped out by the cladding-swelling effect. The cladding-swelling relationship used requires extrapolation far beyond the fluence range where experimental data are available, thus emphasizing the difficulty encountered in attempting such analyses on LMFBR fuel pins to burnup levels considered economically necessary, but for which materials data are not available. (auth)

38553 NON-STEADY-STATE FACTORS IN MODELS FOR SWELLING OF OXIDE FUELS. Hines, D. P.; Oldberg, S.; Zebroski, E. L. (General Electric Co., Sunnyvale, Calif.). Nucl. Appl. Technol.; 9: 338-45(Sep 1970).

The validity of some of the assumptions concerning fuel pin swelling in models based on steady expansion of the fuel with increasing burnup is examined. High precision fuel pin profilometer measurements which suggest the existence of a complex system of local stress conditions are described and are used as the basis for analysis of a cylindrical mixed-oxide fuel pin operating under liquid-metal-cooled fast breeder reactor conditions. The analysis indicates that a part of the cladding deformation is due to ratcheting caused by thermal expansion-interaction of the fuel and cladding during power or temperature changes and not entirely to fission product induced swelling of the fuel. Hypotheses are presented concerning the nature of the fuel-clad interaction in the fast flux irradiated mixed-oxide fuel pins. 22 references. (H.D.R.)

38554 DETERMINATION OF THE TIME CHANGE OF A DOMAIN DEFINED BY A SYSTEM OF PARTIAL DIFFERENTIAL EQUATIONS. APPLICATION TO A NUCLEAR FUEL. Charetton, H.; Corriol, J. L.; Poulard, P. (CEN, Cadarache, France). pp 96-101 of Analog and Hybrid Computation Applied to Nuclear Energy. Brussels, Presses Academiques Europeennes (1969). (In French).

From International Symposium on Analogue and Hybrid Computation Applied to Nuclear Energy, Versailles, France. See CONF-680941.

Fast reactor mixed-oxide fuels cannot be operated at high linear power levels without the risk of melting the core. A method for determining the optimum curve of the power gradient, without melting the core, to obtain the desired power and maximum fuel life is described. (H.D.R.)

Auxiliary and Emergency Systems

38555 (CONF-700608-4) DESIGN OF SPRAY ADDITIVE SYSTEMS. Gallagher, J. L.; Green, L. D.; Marchese, R. T. (Westinghouse Electric Corp., Pittsburgh, Pa.). [ndl. 19p.

From American Nuclear Society Meeting, Los Angeles, Calif.

In many pressurized water reactors, containment spray is used to remove fission products, particularly iodine, from the containment atmosphere following a loss-of-coolant accident. Elemental iodine is absorbed into the spray drops as they fall through the containment. To achieve permanent removal of the iodine from the containment atmosphere, the spray solution contains ~0.2 M boric acid and ~0.15 M sodium hydroxide. The Spray Additive System and the design criteria used in large nuclear power plants to ensure that the containment spray solution can perform its iodine removal function are described. The iodine removal spray solution is obtained by mixing a 30 weight percent sodium hydroxide solution with a 1.2 weight percent boric acid solution. Following a loss-of-coolant accident, the source of spray water is the refueling water storage tank. A portion of the containment spray pump flow is recirculated from the pump and discharged through an eductor to provide the motive flow for the sodium hydroxide addition from the spray additive tank. The addition of sodium hydroxide to the containment spray solution raises the pH of the solution from 4.5 to approximately 10.0. The pH adjustment provides a greater affinity for iodine than does diluted boric acid. At the completion of the injection phase of the accident, when the refueling water storage tank is empty, it is required to have the sump at a pH of 8.3 or greater to keep the absorbed iodine in solution. During the injection phase, the pH of the spray solution should not exceed 10.0 to prevent corrosion of materials inside the containment. Since the spray additive system is a safeguard system, the system is designed to meet the single failure criteria by providing redundant equipment where required. Separability of instrumentation and electrical components is required. Means to periodically test the eductors is provided to meet plant chemical specifications. Safeguard monitor lights are provided in the control room for the remotely operated valves. The spray additive system, using the eductor principle, has been successfully tested, and this design is currently being implemented on all Westinghouse plants that require iodine removal by chemical spray. (auth)

38556 (CONF-700608-6) EFFECT OF FUEL ROD FAILURES ON BOILING WATER REACTOR CORE SPRAY STANDBY COOLING PERFORMANCE. Bock, Richard G.; Duncan, John D.; Leonard, James E. (Westinghouse Electric Corp., Pittsburgh, Pa.). [1970]. 22p.

From American Nuclear Society Meeting, Los Angeles, Calif.

The first full length, electrically heated, 49-rod, Zircaloy-clad simulated BWR fuel bundle with internally pressurized rods was spray cooled under loss-of-coolant conditions. The heater rods were internally pressurized with argon to simulate fission product gas inventory. The temperature response, perforation and oxidation of the bundle cladding is described. Many perforations and severe rod distortions occurred near the center of the bundle. Nevertheless, spray cooling, which was initiated at a maximum cladding temperature of 1920°F was effective in limiting cladding temperatures to approximately 2250°F. Electrical failure of 10 heater rods complicated the interpretation of the results, that is, it is estimated that the maximum temperature would have been approximately 2360°F had the failure not occurred. The maximum coolant flow area reduction around a single rod caused by local perforations was 50%. However, this flow area reduction did not appreciably impair the effectiveness of the spray cooling system. That is, analysis performed using current loss-of-coolant techniques and heat transfer coefficients derived from stainless steel-clad bundle tests predicted the maximum cladding temperature to within 20°F. 10 references. (auth)

38557 (CONF-700608-14) THE EFFECT OF FUEL ROD FAILURE ON EMERGENCY CORE COOLING SYSTEM DESIGN FOR BWR'S. Hench, J. E.; Liffengren, D. J. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). [1970]. 19p.

From American Nuclear Society Meeting, Los Angeles, Calif.

The experimental results of fuel rod failure on the heat transfer effectiveness of spray cooling a Zircaloy clad simulated BWR fuel bundle were evaluated from the design engineer's viewpoint to determine the adequacy of the emergency core cooling system design. The fundamental purpose of the ECCS is to prevent a gross core meltdown following a loss of coolant accident. The ECC system achieves this goal by limiting fuel rod temperatures following a loss of coolant accident to less than 2700°F, the temperature limit which defines the ability to maintain gross core geometry by avoiding cladding fragmentation upon cooldown. The overall results of the full size 49 rod Zircaloy-clad internally pressurized bundle indicate that the ballooning and perforation associated with cladding failure did not significantly change the heat transfer effectiveness (i.e., peak cladding temperatures) of the spray cooling mode of the ECCS. Furthermore the distortion was local in nature such that the flow area reduction would not affect the ability of the flooding mode of the ECCS to accomplish the design objectives. The present BWR ECCS can therefore withstand significant degradation before any gross core cladding damage could result. The redundancy in core cooling methods provided, the conservatisms used in the core heat analyses and the built-in margins in the required coolant flow rates together demonstrate the adequacy of the present ECCS to protect the reactor core following a loss of coolant accident. 12 references. (auth)

38558 (CONF-700608-16) IODINE REMOVAL IN THE ICE CONDENSER SYSTEM. Malinowski, D. D.; Picone, L. F. (Westinghouse Electric Corp., Pittsburgh, Pa. Nuclear Energy Systems Div.). [1970]. 22p.

From American Nuclear Society Meeting, Los Angeles, Calif.

The removal of gaseous elemental iodine from the vapor stream entering an ice condenser unit was studied for the effects of vapor composition, ice additives, ice loading, vapor temperature, flow channels, flow characteristics, and iodine concentration. It was found that alkaline additives enhance the retention of iodine in the ice melt by hydrolysis reactions which convert the iodine to nonvolatile, soluble forms of iodide and iodate. The effect of the iodine content in the steam/air mixtures at the levels studied, was found to be small. The iodine removal was strongly influenced by the fraction of air in the steam/air vapor mixture. Several tests using methyl iodide in place of elemental iodine indicated that the ice would not be an efficient means for removal of organic halides. 3 references. (auth)

38559 (DP-Report-81) THE INFLUENCE OF FUEL BOX PERMEABILITY ON FISSION PRODUCT HEATING IN THE DRAGON PURGE STREAM AND FISSION PRODUCT PLANT. Project DRAGON. Crawley, D. B. (Atomic Energy Establishment, Winfrith (England)). Feb 1962. 32p. Dep. CFSTI.

Calculations made on the escape and distribution of the volatile fission products, under equilibrium conditions, in the Dragon Reactor Experiment are presented. Data are provided to give information to the designers of the Fission Product Trapping System regarding the heat load in various sections of the plant. (auth)

38560 (DUN-6653) NOBLE GAS CONFINEMENT STUDIES. Quarterly Report, October-December 1969. Mecca, J. E.; Etheridge, E. L.; Jensen, H. F. (Douglas United Nuclear, Inc., Richland, Wash.). Contract AT(45-1)-1857. 47p. Dep. CFSTI.

The development of two possible methods of controlling the releases of chemically inert gaseous, fission products (xenon and krypton) which would occur as a result of fuel melting accidents is described. Methods being investigated are encapsulation in a high expansion foam, and adsorption in a porous cryogenic bed. 4 references. (auth)

38561 (EURFNR-728) SHUTDOWN OF A FAST SODIUM-COOLED REACTOR WITH NEUTRON ABSORBING ADDITIVES IN THE COOLANT. Dorner, S.; Schroeter, K. (Kernforschungszentrum, Karlsruhe (West Germany). Insitut fuer Neutronenphysik und Reaktortechnik). Translation of report KFK-1048. 16p. Dep. CFSTI.

Work Performed under United States-Euratom Fast Reactor Exchange Program.

A theoretical analysis is performed of a Na-cooled fast reactor excursion with core deformation. To achieve a sudden shutdown in such an emergency, addition of Li to the Na coolant appears most suitable and technically feasible. Due to its high neutron cross section, ^{6}Li must be employed. For the Li-Na alloy the following properties are discussed: rate of mixture, corrosive behavior, and separation of Na and Li. Results of the analysis are summarized in four tables. 10 references. (H.B.G.)

38562 (NEDO-10179) EFFECTS OF CLADDING TEMPERATURE AND MATERIAL ON ECCS PERFORMANCE. Liffengren, D. J. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Jun 1970. 62p. Dep. CFSTI.

The effects of cladding temperature and material on the boiling water reactor Emergency Core Cooling System (ECCS) performance are investigated. The experimental results of simulated full-length, full-size bundles with electrically heated rods subjected to cooling by spraying or flooding are presented. The results of these experimental tests indicate that the ECCS is effective at temperature levels significantly higher than those predicted, over the entire postulated loss-of-coolant accident (LOCA) break area range up to and including the design basis accident. Therefore, the ECCS can maintain basic core geometry and prevent melting of the fuel rod cladding. Furthermore, any effect of material on the performance of the ECCS is limited to temperature levels above approximately 2300°F where the metal-water reaction of the Zircaloy becomes significant. Also the basic differences in material properties can be accounted for by analysis. (auth)

38563 NUCLEAR REACTOR CONTAINMENT SYSTEM. (to Combustion Engineering Inc.). British Patent 1,198,090. 8 Jul 1970. Priority date 29 Dec 1966, United States.

REACTOR CONTAINMENT SYSTEMS—design parameters of value regulated pressure suppression, for pressurized water reactors

REACTORS, PRESSURIZED-WATER—containment system for, design of value regulated pressure suppression (D,C.C.)

38564 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Benzer, Hartwig. British Patent 1,196,715. 1 Jul 1970. Filed 18 Oct 1968.

Reference is made to fast reactors with high pressure gas cooling. A disadvantage of such reactors is that in the event of an incident causing a fall in gas pressure the cooling effect is sharply reduced, with the possibility of dangerous conditions being set up. Pressure loss in gas cooled reactors is one of the most dangerous causes of breakdown, and the risk of such breakdown limits the amount of pressure employed. In the system described means are provided for circulating high pressure gas in a primary system arranged in a secondary system. The gas pressure in the primary system is maintained at 17 atmospheres, while the gas pressure in the secondary system is at a value intermediate between the ambient pressure and the pressure in the primary system. The secondary system pressure is maintained at such a value so that on equalisation of the pressure in the two systems the resultant pressure does not fall below a value such that the quantity of gas circulated by a fan in the primary system can no longer effect the required heat removal after shutdown. The primary and secondary systems may contain different gases. Water may be used to remove heat from the gas in the primary system, the water being circulated at a pressure of 100 to 400 atmospheres and the pressure of the gas in the primary system being the same as the water pressure. The arrangement may be such that on reduction of the pressure in the primary system the water pressure is reduced by a corresponding amount. The volume of the secondary system may be substantially larger than that of the primary system so that on pressure equalisation between the two systems, on occurrence of a breakdown, the pressure rise in the secondary system is insignificant. (UK)

38565 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Cave, Leslie; Arickner, John Richard (to Atomic Power Constructions Ltd.). British Patent 1,195,670. 17 Jun 1970. Filed 4 Oct 1966.

Reference is made to emergency shutdown systems ("fuses"), with particular reference to gas-cooled reactors. In the system described a tensile member, including a nuclear "fuse," is provided which extends longitudinally between the fuel element retaining means of a nuclear fuel stringer. The tensile member may comprise a hollow tie bar, which has two compartments separated by a rupturable barrier, the first compartment containing a neutron poisoning material. The barrier is rupturable as a result of increase of temperature and rise in pressure in the first compartment. The first compartment may have a smaller internal diameter than the second compartment and the rupturable diaphragm may be located across the shoulder interconnecting the two compartments or across an orifice formed in a solid barrier between the two compartments. The rupturable barrier may be secured by electron beam welding, the neutron poisoning material may be cadmium, and the rupturable barrier material may include boron. (UK)

38566 NUCLEAR REACTOR INSTALLATION. Wilson, Stanley George; Hughes, George William (to United Kingdom Atomic Energy Authority). British Patent 1,195,165. 17 Jun 1970. Filed 21 May 1968.

Reference is made to means for generating foam to blanket any component whose failure could result in loss of reactor coolant and possible fire due to pressure differentials during operation. The means described is particularly, but not exclusively, applicable to gas cooled reactors. The relatively long time available for action to be taken in the event of coolant loss with gas cooled reactors allows for the erection of temporary wire mesh pens to hold the foam where it is required, if it is not desired to erect permanent pens. The optimum foam is highly viscous and innocuous and easily removeable if drawn into the reactor core, and the recommended foam is a long-lived CO_2-filled high expansion aqueous foam, or a similar inert gas filled foam. A gas/water volume ratio of 1200:1 is suitable and achievable. The means for generating the foam can comprise a permanent installation with foam branches, or a portable generator having means for spraying foam solution on to the mesh and gas circulators to provide a draught of gas inwardly through the mesh sufficient to generate foam from the solution. A portable generator will enable foam to be inserted into ruptured piping in order to plug the piping. If such a system is applied to a liquid-cooled reactor the foam blanket must be thicker and must be produced very rapidly. (UK)

38567 GAS-COOLED NUCLEAR REACTOR. Wilson, Stanley George; Hughes, George William (to United Kingdom Atomic Energy Authority). British Patent 1,195,166. 17 Jun 1970. Filed 21 May 1968.

A factor which influences the design of gas-cooled reactors is limitation of the size of coolant leakage in the case of accident, taking into account that heat transfer must be adequate to remove fuel decay heat for at least half an hour while the coolant is at atmospheric pressure as a result of the accident. In the system described means are provided for introducing a non-combustion supporting gas-filled aqueous high expansion foam into the reactor fuel channels through a coolant inlet. The inlet can be a plenum from which coolant flows directly, or through a graphite moderating structure, into the fuel channels, the former arrangement being preferred. The foam may comprise 800 parts of gas (typically CO_2) to each part of water by volume, so that the water is widely dispersed and gives rise neither to thermal shock nor to disturbances of the neutron physics of the core. Such a foam has better heat transfer properties than the gas alone by a factor of about 15. The system may include apparatus for foam generation and a foam duct leading into the inlet plenum, or may include a foam solution dispenser together with a wire mesh positioned in a coolant inlet to receive the foam solution and a gas circulator to cause a draught through the mesh sufficient to generate foam from the solution and convey it to the desired region. The latent heat of evaporation of the foam provides extra cooling. (UK)

Safety and Siting

Refer also to abstracts 36356 and 38511.

38568 (BAW-10008(Pt.1)(Rev.1)) REACTOR INTERNALS STRESS AND DEFLECTION DUE TO LOSS-OF-COOLANT ACCIDENT AND MAXIMUM HYPOTHETICAL EARTHQUAKE. (Babcock and Wilcox Co., Lynchburg, Va. Nuclear Power Generation Dept.). Jun 1970. 143p.

Following a loss-of-coolant accident (LOCA), the reactor, including the internals and the core, is subjected to two major types of loading. The first is horizontal shaking due to the side thrust resulting from the rupture of a reactor coolant pipe, in which the resultant motion of the vessel is transmitted to the internals through the upper flange of the core support shield. The second type of loading results from transient differential pressures that are applied to the core and the internals. Examples of this type of loading are the vertical pressure difference across the core and the external pressure load on the core support shield resulting from a rupture of reactor coolant piping in the hot leg. Similar loads result from an earthquake. Horizontal shaking from the horizontal ground motion excites the reactor through the vessel support skirt. Vertical ground motion produces inertial loading of the core on the lower grid plate, which is qualitatively comparable to the core pressure drop load. The reactor internals were analyzed to determine the magnitudes and the effects of all these loads, including simultaneous occurrences. The basis for calculating loads is presented. The method for calculating transient pressure differentials during a LOCA, including general pressure-time relationships and the influence of local pressure gradients near the inlet and outlet nozzles, is outlined, and the results of the analysis are given. The basis for earthquake loads and the secondary loads resulting from vertical core motion is also given. The effect of these loads on the stress and deflection of the several internal components is presented. Elastic behavior is assumed in the analysis. It is shown that stresses and deflections do not exceed those allowed. Appendixes present: discussions of the bases for allowable stress and methods of determining these allowable stresses; the effect of irradiation on the material properties and deformation limits for internals; the details of the dynamic model used for the LOCA thrust and horizontal seismic analyses; a flowchart for the internals stress analysis and a brief description of all the computer codes used; and several examples of the actual stress analyses performed on internals components. (11 references) (auth)

38569 (CONF-700608-9) EFFECT OF FLOW BLOCKAGE ON BOTTOM COOLING HEAT TRANSFER EFFECTIVENESS, (FLECHT). Cermak, J. O.; Leyse, R. H.; Dominicis, D. P. (Westinghouse Electric Corp., Pittsburgh, Pa. Nuclear Energy Systems Div. Idaho Nuclear Corp., Idaho Falls). [1970]. 12p.

The effects of flow blockage on bottom cooling heat transfer effectiveness were studied in the PWR-FLECHT program. The purpose of the tests was to simulate the flow constriction which might

occur in the event of axial rod distortion or clad swelling during a loss of coolant accident. Blockages of 50% and 75% of the flow areas of a 5 × 5 array in the center of a 7 × 7 rod bundle were studied with 12 foot long heater rods with an axial cosine heat generation distribution of 1.66 peak to average and decay heat simulation. The 7 × 7 array simulates a 7 × 7 section of a PWR fuel element. The test section consists of 42 heated rods (fuel rods) and 7 non-heated tubes (control rod thimbles). The heater rods contain internal thermocouples pressed against the inside wall. Flow blockage is effected by a $\frac{1}{8}$" thick flat plate mounted at the peak heat generation location (6' elevation) with the heater rod thermocouples being approximately 1 inch downstream from the flow blockage plate and also at two foot intervals above and below the plate. Test procedures and results are presented. (4 references) (auth)

38570 (CONF-700608-10) HEAT TRANSFER BEHAVIOR FOR FLOW BLOCKAGE OF A FUEL ROD. Cermak, J. O.; Kitzes, A. S.; Tong, L. S. (Westinghouse Electric Corp., Pittsburgh, Pa. Nuclear Energy Systems Div.). [1970]. 6p.

From American Nuclear Society Meeting, Los Angeles, Calif.

The heat transfer behavior of a fuel rod with flow blockage during the bottom flood cooling has been studied in FLECHT by investigating blockage effects caused by heater rod distortion. Two bottom flooding FLECHT tests were performed with Zircaloy clad heater rods. Both test sections showed heater rod distortion. The test section consisted of a 7 × 7 rod bundle simulating a 7 × 7 section of a PWR fuel element. Heater rods were 12 foot long with an axial cosine heat generation distribution of 1.66 peak to average and decay heat simulation. There were 42 heated rods (fuel rods) and 7 non-heated tubes (control rod thimbles) with the heater rods containing internal thermocouples pressed against the inside wall. Thermocouples were located at the 2', 4', 6', 8' and 10' elevations. Test conditions and results are presented. (auth)

38571 (CONF-700608-12) POST LOCA HYDROGEN GENERATION IN PWR CONTAINMENTS. Fletcher, W. D.; Bell, M. J.; Marchese, R. T.; Gallagher, J. L. (Westinghouse Electric Corp., Pittsburgh, Pa. Nuclear Energy Systems Div.). [1970]. 26p.

From American Nuclear Society Meeting, Los Angeles, Calif.

The production of hydrogen due to the radiolysis of reactor containment spray solutions has been investigated. An experimental program was conducted to determine the extent of radiolytic hydrogen production in a laboratory system modeled after the nuclear plant systems. Radiolysis of the solution, as it would occur in the containment sump and in the reactor core, was studied. Experimental results indicate a conservative rate of hydrogen production due to sump solution radiolysis of 0.30 molecules/100 eV of energy absorbed by the solution. Experimental studies of core solution radiolysis have shown the extent of hydrogen production from this source is limited by the attainment of a steady-state hydrogen concentration in the solution passing through the core. Based on experimental data, an analytic model was derived which conservatively approximates the hydrogen production process as it would occur in the nuclear plant should a hypothetical design basis accident occur. The significance of other sources of hydrogen in the post accident environment also is discussed. (auth)

38572 (DP-Report-58) THE VARIATION OF HELIUM TEMPERATURE IN THE DRAGON REACTOR AFTER LOSS OF ELECTRICAL SUPPLY. Project DRAGON. Blake, J. P. H. (Atomic Energy Establishment, Winfrith (England)). Oct 1961. 19p. Dep. CFSTI.

The effect of complete failure of electrical supplies on the Dragon Reactor Experiment is predicted in terms of primary circuit temperatures. It is found that, even with pessimistic assumptions, maximum helium temperatures remain below the level where damage to the primary circuit ducting could occur. (auth)

38573 (DP-Report-70) THE EFFECT OF A FINE HOLE ON THE CHARACTERISTICS OF THE DRAGON FUEL BOX. Project DRAGON. Mayerhofer, S.; Beutler, H.; Good, P. D. (Atomic Energy Establishment, Winfrith (England)). Dec 1961. 24p. Dep. CFSTI.

The short lived fission products must be retained in the DRAGON reactor long enough to surrender their heat inside the reactor instead of the fission product traps. This necessitates a low permeability fuel box. On the other hand, during start up, a considerable pressure develops inside the fuel box owing to the expansion of gas. This could cause bursting of the fuel box if the permeability was too low. A compromise consisting of using a fuel box with as low a permeability as possible and a small hole drilled in it to effect gas pressure equalization is described. (auth)

38574 (DP-Report-94) THE CONTAINMENT OF HIGH TEMPERATURE REACTORS. Project DRAGON. Schmidt, H. W.; Allen, J. (Atomic Energy Establishment, Winfrith (England)). May 1962. 22p. Dep. CFSTI.

The requirements for the containment of Dragon Reactor are described. A system of multiple containment has been adopted. The system is described and compared with alternative schemes. (3 references) (auth)

38575 (IN-1381) FISSION PRODUCT BEHAVIOR EXPERIMENTAL PROGRAM. Technical Description. (Idaho Nuclear Corp., Idaho Falls). Jun 1970. Contract AT(10-1)-1230. 43p. Dep. CFSTI.

The Fission Product Behavior Experimental Program is intended to provide experimental data which will be used for assessing the adequacy of analytical models developed to describe the release of fission products and their subsequent behavior in a loss-of-coolant accident. Four specific areas are to be studied: transport properties of noble gases and iodine in porous ceramic membranes; fission product release upon cladding failure and subsequent transport of fission products through the reactor system to the containment; the time-dependent depletion of fission products in containment atmospheres; and the factors affecting the chemical state of radioiodine in containment atmospheres. A technical description of the program is presented. Experimental measurements are included. (26 references) (auth)

38576 (IN-1385) BOILING WATER REACTOR–FULL LENGTH EMERGENCY COOLING HEAT TRANSFER (BWR–FLECHT) TESTS PROJECT. Technical Description. (Idaho Nuclear Corp., Idaho Falls). Jun 1970. Contract AT(10-1)-1230. 43p. Dep. CFSTI.

The Boiling Water Reactor–Full Length Emergency Cooling Heat Transfer (BWR-FLECHT) Tests Project is directed toward experimental investigation of the thermal and hydraulic aspects of terminating the core thermal transient following a loss-of-coolant accident by means of emergency core coolant injection. A technical description of the BWR-FLECHT project is presented. Included are the technical basis for the project, the accomplishments achieved thus far, a detailed test plan, and a description of the facilities. BWR-FLECHT tests are conducted using full-length 49-rod, electrically heated bundles to simulate nuclear fuel pins. Both stainless steel- and Zircaloy-clad bundles are used, and both core spray and core flooding techniques of emergency core coolant injection are employed. Tests are performed with either steady state or transient power input to the rods. The stainless steel-clad bundles are tested in sequences to obtain parametric heat transfer information; whereas, the Zircaloy-clad bundles are tested to determine the behavior of Zircaloy during the ECC phase of a loss-of-coolant accident and to provide demonstrations of ECC system effectiveness. Test results currently are available for bottom flooding and top spraying for various bundle powers, flow rates, and initial temperatures. The heat transfer characteristics of the BWR emergency cooling systems have been thoroughly investigated for initial temperatures up to 1800°F at atmospheric pressures under both steady state and transient conditions. The test results show that for both bottom flooding and top spraying with delayed flooding coolant injection modes, the ECC systems for current generation BWR reactors are capable of terminating the core thermal transient over the parameter ranges investigated. 10 references. (auth)

38577 (IN-1387) SIMULATED EMERGENCY FLOW EFFECTS TESTS (SEFET) PROJECT. Technical Description. (Idaho Nuclear Corp., Idaho Falls). Jun 1970. Contract AT(10-1)-1230. 37p. Dep. CFSTI.

The technical program for the SEFET Project that is designed to determine the magnitude of the radial flow and coolant bypass problem following a loss-of-coolant accident is described. Calculations indicate that this problem may cancel the margin of safety previously thought to exist in emergency core cooling systems. Since the primary loop pressure drop controls coolant bypass, full-length heater rods and full-length steam generator tubes will be used in SEFET to obtain the same amount of superheating and loop pressure drop as will occur in a pressurized water reactor. The magnitude of radial flow will be controlled by core temperature gradients and the ratio of the hot-to-cold assembly volumes. SEFET rods will be placed in a wedge-shaped array and the power to the rods will be controlled to provide as much, or more, radial flow as will occur in a reactor. 10 references. (auth)

38578 (IN-1399) FINAL RESULTS OF THE CAROLINAS VIRGINIA TUBE REACTOR CONTAINMENT LEAKAGE RATE TESTS. Bingham, G. E. (Idaho Nuclear Corp., Idaho Falls). Jun 1970. Contract AT(10-1)-1230. 135p. Dep. CFSTI.

A number of leakage rate tests were performed on the Carolinas Virginia Tube Reactor containment system to investigate the effects of pressure, temperature, and design basis accident

(DBA) conditions on containment leakage rate. The leakage rates were determined by both the absolute method and the reference vessel method using data from several different leakage-measuring systems and two containment-temperature measuring systems. Presented are the results of the different methods of measuring and calculating leakage rate; the influence of temperature, pressure, and DBA conditions on leakage; and an error analysis of the leakage rate measurement methods and the associated instrumentation systems. 17 references. (auth)

38579 (JUL-603-ST, pp 195-202) ACTIVITY AND SHIELDING: TABLES FOR CALCULATING THE ACTIVITY OF ^{235}U. Schneider, K.; Sauermann, P. F. (Kernforschungsanlage, Juelich (West Germany). Zentralabteilung Strahlenschutz). (In German).

For the safe handling of used fuel elements, knowledge of the contained fission products is necessary, especially of those in gaseous form. Tables are prepared for each fission product, per one watt reactor power, giving their activity interdependency of burn duration and subsequent length of cooling. Differential equations and integrals for the processes are presented. By means of a computer, solutions are calculated and presented in the form of tables and diagrams. Several practical examples for use of the tables are discussed. (H.B.G.)

38580 (KFK-1034) SODIUM-AIR REACTIONS AS REACTOR INTERFERENCE EVENT. Keller, K. (Kernforschungzentrum, Karlsruhe (West Germany). Institut fuer Angewandte Reaktorphysik). Jan 1970. 40p. (In German). Dep. CFSTI (U. S. Sales Only).

Temperature and pressure patterns of sodium-air reactions were derived as functions of the type of sodium burning. The consequences for the containment-charge were indicated. In particular the reaction rates for the various relevant chemical reactions were studied as a function of the reactor incident or the type of sodium burning. (tr-auth)

38581 (NEDG-13064) PRELIMINARY RESULTS OF THE BWR-FLECHT INTERNALLY PRESSURIZED, ZIRCALOY-CLAD BUNDLE, SPRAY COOLING TEST. Leonard, J. E.; Duncan, J. D. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Jan 1970. Contract AT(10-1)-1230; Subcontract S-7044. 37p. Dep. CFSTI.

For Idaho Nuclear Corp., Idaho Falls.

A 12-foot long, 40-rod, Zircaloy-clad BWR fuel bundle was spray cooled under loss-of-coolant conditions. The heater rods were electrically heated to simulate the post accident decay power transient. The rods were internally pressurized with argon to simulate fission product gas inventory. The temperature response and perforation of the bundle cladding is described. Spray cooling was effective in limiting cladding temperatures to approximately 2240°F in spite of the perforations and severe rod distortions which occurred near the center of the bundle. (auth)

38582 (TID-3525(Rev.5)(Suppl.5)) REACTOR SAFETY. A Literature Search. Raleigh, Henry D. (comp.) (Division of Technical Information Extension (AEC), Oak Ridge, Tenn.). Jun 1970. 53p. Dep. CFSTI.

Included are 373 citations to references on safety aspects of nuclear reactor design, siting, materials, engineered safeguards, and operating procedures covering the period from January 1968 through December 1969. Reports cited concern hazards analyses of entire facilities to satisfy construction and operation permit requirements, evaluation of reactor systems and components reliability, and analyses of the consequences of potential accident conditions. Subject, author, corporate author, and report number-availability indexes are included. (auth)

38583 EXPULSION DYNAMICS OF SODIUM AND NONMETALLIC FLUIDS. Singer, Ralph M.; Holtz, Robert E. (Argonne National Lab., Ill.). Atomkernenergie; 15: 211-15(1970).

In studies of the expulsion dynamics of sodium in fast breeder reactor applications, the experimental difficulties involved in measuring vaporization rates and determining flow regimes are well known. Thus, if information obtained from non-metallic fluid tests can be shown to apply to sodium systems, many complicated and expensive experiments may be avoided. Measurements of the expulsion dynamics of water, methanol, and sodium are presented and compared. It is demonstrated that the initial vaporization rate of these three liquids is controlled by the inertia of the liquid column above the vapor phase and a simple vapor slug model can reasonably predict the initial expulsion dynamics. Additionally, the transient expulsion displacement (length of vapor slug) divided by the initial superheat pressure difference for these three liquids is shown to follow a single curve for a wide range of incipient superheats and liquid column heights. These findings lend considerable optimism to the concept of modeling the two-phase behavior of liquid metals with non-metallic fluids. 18 references. (auth)

38584 DECONTAMINATION OF NUCLEAR REACTORS AND EQUIPMENT. Ayres, J. A. (ed.). New York; Ronald Press Company (1970). 840p. $22.50. (TID-25450).

Information concerning decontamination of reactors and equipment is presented under the following subject headings: cleaning and defilming arts in industry; historical survey of decontamination; contamination mechanisms; decontamination and film removal; corrosion; safety in the decontamination of reactors; influence of design on decontamination; planning the decontamination operation; treatment and disposal of decontamination wastes; paints and protective coatings; testing and evaluation; specialized equipment; ultrasonic cleaning; low-temperature water-cooled reactors; decontamination of pressurized-water reactors; boiling water reactors; gas-cooled and other reactor systems; decontamination of equipment; decontamination of buildings and laboratories; and decontamination after widespread release to the environment. (D.C.C.)

38585 NEW TECHNIQUE FOR REACTOR SITING DOSE CALCULATIONS. Willis, C. A. (McDonnell Douglas Astronautics Co., Santa Monica, Calif.); Spangler, G. A.; Rhoades, W. A. Health Phys.; 19: 47-54(Jul 1970).

The COMRADEX code was developed to calculate radiation doses from accidents postulated for advanced reactors with sophisticated engineered safeguards. The use of a direct numerical technique, designed especially for quasilinear differential equations, to solve the leakage and decay chains, permits the inclusion of several special features. These include the capability for considering up to four levels of containment, each with an independent time-varying leak rate. Provision is also included for filtration, particle coagulation and fallout, and special cleanup systems. Shielding may be introduced between the various containment shells. A full fission product inventory (plus special isotopes) is used with input release fractions. Internal doses are determined with the ICRP model. The cloud gamma dose is obtained by integrating over the anisotropic Gaussian cloud; this calculation is simplified by assuming a single air attenuation kernel for all gammas. (auth) (UK)

38586 ANALYTICAL MODEL FOR THE PREDICTION OF DIFFERENTIAL PRESSURE TRANSIENTS IN REACTOR BUILDINGS DURING A LOSS-OF-COOLANT ACCIDENT. Aisch, Dietrich E. (Steinkohlen-Ekektrizitaet Aktiengesellschaft, Essen). Atomkernenergie; 16: 6-10(1970).

During the design basis accident of water cooled power reactors (breaching of a main coolant loop) high energy coolant is rapidly released into the reactor building. The coolant release gives rise to pressure differences between single compartments of the building within the containment vessel. This could lead to the fracture of concrete walls and the severance of safety injection and emergency cooling lines with core melt-down as the ultimate consequence. Basing on the conservation laws of mass and energy and recognizing the thermodynamic properties of steam, a computer code was developed which allows the analysis of the accident transients in a complex reactor building. Special consideration was given to the carry-over of water in the flow of steam and air between compartments. By application of the program, design parameters for the cross sectional area of relief openings and the strength of building structures can be derived. 9 references. (auth)

38587 ESTIMATE OF THE ENHANCEMENT OF FISSION PRODUCT RELEASE FROM MOLTEN FUEL BY THERMALLY INDUCED INTERNAL CIRCULATION. Fontana, M. H. (Oak Ridge National Lab., Tenn.). Nucl. Appl. Technol.; 9: 364-75 (Sep 1970).

The amount of fission products remaining in the molten mass of material that could result from core melt-through must be known to evaluate the heat loads on various parts of the structure, and depends on many factors. An approximate evaluation of diffusion and internal convection as mass transfer mechanisms under fairly quiescent conditions is presented. This condition was chosen because it would result in larger amounts of heat generating fission products remaining in the melt than would be the case with more violent agitation. Internal heat generation in a molten slab of fluid cooled primarily from the upper surface would create a temperature gradient which, at some critical value, would cause internal convection currents due to the greater buoyancy of the hotter material in the lower portions of the melt. These convection currents enhance both the heat and mass transfer from the interior of the molten material to the surface. The heat transfer and rate of release of fission products (using yttrium oxide as an example) from a slab of molten fuel and steel were calculated and the results compared with a diffusion calculation. A sensitivity analysis was performed and the effects of wide variations in the thickness of the melt, viscosity, coefficient of thermal expansion, diffusion coefficient, specific heat, and thermal conduc-

tivity are reported. For the base case of yttrium oxide in 200 tons of molten UO_2 and steel in a slab 17.1 cm thick, the time required to release 80% of the fission product was 9 hours, compared with 40 days for the case where a diffusion model was assumed. (auth)

Power Conversion Systems

38588 METHOD FOR THE OPTIMUM LAYOUT OF INDUSTRIAL NUCLEAR POWER PLANTS WITH HELIUM TURBINES. Bammert, K.; Buende, R. (Technische Univ., Hanover). Atomkernenergie; 15: 240-8(1970). (In German).

The still growing importance of helium cooled reactors for energy supply made it necessary to investigate the manner of using the reactor-heated closed-cycle helium turbine in industrial power plants for the simultaneous generating of electric power and steam. On the base of earlier considerations of the possible arrangements for combined power and steam generation a method is deduced which allows the optimum layout of the cycle. This method of optimization is used in case of saturated-steam generation, then the influence of superheating the steam is regarded. 3 references. (auth)

Research and Test Reactors

Refer also to abstracts 36525, 36652, 38395, 38470, and 38633.

38589 (AERE-M-2281) A SIMPLE TRANSMISSION METHOD FOR MEASURING THE BURN-UP OF ^{113}Cd IN C.C.A. BLADES REMOVED FROM DIDO AND PLUTO. Hawker, B. M. (Atomic Energy Research Establishment, Harwell (England)). Apr 1970. 17p. Dep. CFSTI (U. S. Sales Only). UK 3s.

A simple, quick and fairly accurate technique used to measure the burnup of ^{113}Cd in C.C.A. blade samples is described. The samples are identical to those normally taken for analysis by more complicated methods. (auth) (UK)

38590 (BNWL-1397) CSE PRESSURE VESSEL DEFECT STUDY. Watwood, V. B. Jr.; Anderson, T. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jun 1970. Contract AT(45-1)-1830. 79p. Dep. CFSTI.

Finite element methods are used to predict the behavior of a laminar crack in a thick-walled pressure vessel. An analytical method employing strain energy is developed to evaluate the stress intensity factor for a crack in a body of arbitrary shape. The method is illustrated by several examples, and bounds to exact solutions are discussed. Modification of an existing finite element computer code to include calculation of stored elastic strain energy is described and the program is employed to obtain stress resultants in a pressure vessel under pressure loads and transient thermal shock. Fracture mechanics methods are then employed to predict possible unstable crack growth and estimated growth rates for the pressure vessel defect. 21 references. (auth)

38591 (CEA-CONF-1532) FIVE YEARS OPERATIONAL EXPERIENCE WITH CELLS ASSOCIATED WITH RESEARCH REACTORS. Briffaud, Georges (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1970. 15p. (In French). (CONF-700523-1). Dep. CFSTI (U. S. Sales Only).

From 12th Meeting on Hot Laboratories, Cadarache, France.

The advantages offered by the dismantling cells associated with research reactors and especially swimming pool reactors in respect to yield, economy and safety are examined by means of large transfer channels. Successive loading and unloading of the reactor are taken care of by the associated cells which allow various possible means of irradiation. The cells also allow the irradiated samples to be distributed more quickly at low cost to different laboratories and some nondestructive tests to be made in course of irradiation. A large cell divided into two parts by an internal wall seems to realize the optimal conditions (OSIRIS). The cells are easily accessible. These cells also make it possible for a device to be repaired in course of irradiation. (auth) (France)

38592 (DOCKET-50231-48) SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR. Quarterly Plant Operations Report No. 4, February 1-April 30, 1970. (General Electric Co., Sunnyvale, Calif. Breeder Reactor Development Operation). 18 Jun 1970. 20p. Dep. CFSTI.

38593 (DOCKET-50231-49) SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR. Malfunction of the Reactor Vessel Vacuum Breaker System. (General Electric Co., Sunnyvale, Calif. Breeder Reactor Development Operation). 29 Jun 1970. 3p. Dep. CFSTI.

38594 (DOCKET-50231-50) SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR. License No. DR-15; Technical Specifications Proposed Change No. 3. (General Electric Co., Sunnyvale, Calif. Breeder Reactor Development Operation). 8 Jul 1970. 14p. Dep. CFSTI.

Core physics calculations and measurements to permit 20 MW(t) operation with centrally located guinea pig fuel rods of PuO_2-UO_2 are presented. (D.C.C.)

38595 (DP-Report-45) PREPARATION OF CAPSULE FOR IRRADIATION IN THE HAWKER SIDDELEY CORE REPLACEMENT RIG IN RISOE, DENMARK. Project DRAGON. Redding, G. B.; Burnett, R. C.; Beutler, H.; Gough, J. R. C. (Atomic Energy Establishment, Winfrith (England)). Nov 1961. 20p. Dep. CFSTI.

Two capsules containing cold compacted, fission product emitting fuel inserts are fabricated for irradiation at Riso. The fabrication of the fuel, the sealing of the low permeability fuel boxes, permeability measurements and the final assembly are described. (auth)

38596 (IAERU-7001) MEASUREMENTS OF THE FAST NEUTRON SPECTRA IN THE REACTOR CORE AND THE THERMAL COLUMN OF THE RIKKYO REACTOR. Kitahara, Akiharu; Harasawa, Susumu (Rikkyo Univ., Yokosuka (Japan). Inst. for Atomic Energy). 1970. 32p. Dep. CFSTI (U. S. Sales Only).

The fast neutron spectra in the core and the thermal column of the Rikkyo reactor were measured by the foil activation method. The four kinds of material, indium, nickel, titanium and aluminium, were used for the detecting foils. The calculation method of spectra was the least-squares series expansion proposed by G. Di Cola and A. Rota. Three fictitious spectra were used in order to test the effect of assortment of foils and the accuracy of the calculation method. In two cases of the fictitious spectra, fission spectrum and the neutron spectrum in the water moderator reactor, the calculated spectra were little affected by assortment of foils. The accuracy of the calculation was satisfactory in this measurement. In case of the spectrum having a depression, the calculated spectra near by the depression did not represent the real spectra quantitatively. The calculated results did indicate, however, the existence of the depression and the energy of the depression accurately. The fast neutron spectrum from the measured activation rates in the center of the reactor core was similar to the fission neutron spectrum, while at the upper part of the core, the spectrum around 6 MeV was a little lower than the fission one. On the other hand, the obtained spectrum in the thermal column differed from the fission neutron spectrum in having the fairly large depression near by 3.5 MeV. The fast neutron flux was about one per cent of the thermal neutron flux. (auth)

38597 (KFK-1031) DIRECT ELECTRICALLY HEATED UO_2 FUEL RODS. Freund, D.; Schikarski, W. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Reaktorphysik). Feb 1970. 47p. (In German). Dep. CFSTI (U. S. Sales Only).

The new method described allows heating of sintered UO_2-rods by direct electric current without an internal axial metallic resistance heater. The temperature distribution of a direct electrically heated UO_2-rod is calculated by means of a digital computer program based upon radial power balance. The comparison between the direct electrically heated rod and the nuclear reactor fuel rod shows that a good simulation of the nuclear fuel temperature distribution can be achieved. Experimental and measuring devices are described. The stationary electrical heating of the UO_2-pin with electrical energy requires a power controlled circuit. The dynamic conditions are simulated by a pulse current taken from a bank of capacitors. The method allows investigations on thermal and thermodynamic behavior of UO_2-fuel pins. Structural changes and physical effects due to temperature gradients can be simulated. Performance of UO_2-pins under dynamic conditions depending only on thermal influences is investigated. The method allows a partial simulation of pin failure and of nuclear reactor excursions with well defined parameters. Preliminary results with sintered UO_2-pins are reported. (15 references) (auth)

38598 (KFK-1033) THE DEVELOPMENT OF SEFOR ENERGY PROBES. Bumm, H.; Glauner, H. W.; Ruehl, E.; Schikarski, W.; Tavosanis, M. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Reaktorphysik). Dec 1969. 51p. (In German). (EUR-4307). Dep. CFSTI (U. S. Sales Only).

The development of the SEFOR energy probes for measurement of power transients is described. Energy probes use the direct temperature increase in fissionable material resulting from nuclear fission for the measurement of the power or the integral temperature change for measurement of the energy in a power

excursion. A survey is given on the construction and material technological advancements in the development of the SEP. The determination of the dynamic properties by research in a cyclotron and a research reactor is reported. The SEP's studied have a response time constant which is below the required value of $\tau_A = 1$ msec and a heat conduction constant which is sufficiently large (about 350 msec) so that the measurement is not affected. An extensive discussion of the systematic errors, which can occur in the stationary and dynamic operation of the SEP's is given. (tr-auth)

38599 (KURRI-TR-70) TEMPERATURE DISTRIBUTION IN BIOLOGICAL SHIELD CONCRETE OF KUR. Tsutsui, Tenson; Nishimaki, Kenzo; Mori, Chuzi; Takahashi, Kanzi (Kyoto Univ. (Japan). Research Reactor Inst.). 4 Dec 1969. 16p. (In Japanese). Dep. CFSTI (U. S. Sales Only).

In the biological shield concrete of KUR, thermocouples and strain gauges were placed in both reinforcement and concrete for the evaluation of the safety and character of the shield. The temperature distribution and stress when the power of KUR was increased to 5 MW were measured. The results of the measurements of temperature distributions in the biological shield concrete are presented. From these measurements, the biological shield concrete of KUR is sufficiently safe and strong against the stress even when the power of KUR is increased to 5 MW. (auth)

38600 (KURRI-TR-72) PREPARATION OF IN-CORE FLOW-METERS AND MEASUREMENTS OF THE CORE FLOW DISTRIBUTIONS OF KYOTO UNIVERSITY REACTOR. Sugimoto, Masaaki (Kyoto Univ. (Japan). Reactor Research Inst.). 27 Dec 1969. 10p. (In Japanese). Dep. CFSTI (U. S. Sales Only).

Two kinds of coolant flow-meters making use of different principles were prepared for measurements of flow-rate distributions in the fuel elements of the reactor core. The distributions in the KUR core were investigated with these flow-meters under conditions of forced circulation cooling and natural convection cooling. A turbine type flow-meter was suitable for the measurement on the forced cooling, and it gave a good proportionality between the flow-rate and the revolution speed in digital counts. On the other hand, a thermocouple type of velocity meter was applied to the measurements of the natural convective flow of water, and it showed much availability in the small velocity range of a few cm/sec, even under the existence of the water temperature fluctuations. As the results of the in-core measurements using these flow-meters, the homogeneous flow distributions under the forced cooling and the large convective flow comparing to the designed value of KUR were ascertained. Additionally, a flow-speed of about 1 cm/sec was noticed under the shutdown condition of the reactor, and it was explained to be the convective flow due to the decay-heat of the core. (auth)

38601 (LA-4218) CALCULATION AND INTERPRETATION OF THE UHTREX CRITICAL EXPERIMENTS. Carmichael, B. M.; Vigil, J. C.; Meem, J. L. Jr. (Los Alamos Scientific Lab., N. Mex. Aug 1969. Contract W-7405-eng-36. 56p. Dep. CFSTI.

The UHTREX (Ultra High Temperature Reactor Experiment) critical experiments are analyzed in a detailed comparison of calculations with experiment. Critical masses and flux profiles; control rod, fuel, and void worths; and temperature and pressure coefficients of reactivity for the reactor operating at low power and ambient temperature are discussed. (29 references) (auth)

38602 (LA-4449) A RISK ANALYSIS OF THE OMEGA WEST REACTOR. Otway, Harry J.; Battat, Morris E.; Lohrding, Ronald K.; Turner, Robert D.; Cubitt, Richard L. (Los Alamos Scientific Lab., N. Mex.). Mar 1970. Contract W-7405-eng-36. 34p. Dep. CFSTI.

A method for estimating the risk from reactor installations is presented and applied to the Omega West Reactor, an 8-MW(t) research reactor at Los Alamos, New Mexico. The method, which considers both accident probabilities and various wind and weather conditions, estimates individual risk as a function of direction and distance from the reactor and estimates the total detriment to the community as the consequence of reactor accidents. The somatic risk due to thyroid carcinoma from ^{131}I uptake, the somatic risks of leukemia and other neoplasms from whole-body irradiation, the genetic risk, and nonspecific life-shortening were considered. The individual somatic risk at the nearest habitation was found to be 5×10^{-10}/yr, and the total detriment to the community was 4.5×10^{-4} deaths per year of reactor operation. Statistical treatment of reactor operating history and test data to obtain reliability estimates is outlined. The results of this study are compared with those from analysis of a 3200-MW(t) pressurized water reactor. (auth)

38603 (ORNL-TM-3035) DESCRIPTION AND SAFETY OF THE POOL CRITICAL ASSEMBLY. Stanford, L. E. (Oak Ridge National Lab., Tenn.). 4 May 1970. 61p. Dep. CFSTI.

The Pool Critical Assembly (PCA) is basically similar and in most respects identical to the natural-convection cooled, 1-MW version of the Bulk Shielding Reactor (BSR). A description of the PCA and safety requirements for operation is presented. (17 references) (auth)

38604 (ORNL-TM-3074) OAK RIDGE RESEARCH REACTOR QUARTERLY REPORT, JANUARY–MARCH OF 1970. Tabor, W. H.; Hurt III, S. S. (Oak Ridge National Lab., Tenn.). 26 Jun 1970. 30p. Dep. CFSTI.

The ORR operated at an average power level of 30 Mw for 87.4% of the time during January, February, and March of 1970. Approximately 2975 g of ^{235}U were consumed, while maintaining a very good balance between the number of fuel elements placed in service (25) and the number declared spent (26). The reactor was scheduled down on six occasions during the quarter and encountered but one unscheduled shutdown which accounted for approximately 2% of the total downtime. Downtime for the quarter, however, was approximately 10% less than the average per quarter in 1969, primarily because less time was needed for decontaminating the pool surfaces. Instrumentation and equipment throughout the reactor complex required very little maintenance and, in general, operated quite satisfactorily. The quick-opening valve, no longer considered a necessary part of the emergency cooling system, was removed from service by installation of a blank flange at the exit side of the valve. The radioactivity of the reactor water increased to about two times normal on February 16, 1970, because of an apparent breach of cladding of element 43L. The element was identified and isolated on February 17 during a scheduled refueling shutdown. Loss of operating time was minimal, and the contaminants were confined to the water systems. (auth)

38605 (PAEC(D)-699) PRR-1 FUEL ELEMENTS (2nd BATCH). Corpus, Guillermo C. (Philippine Atomic Research Center, Manila). Aug 1969. 39p. Dep. CFSTI (U. S. Sales Only).

Twenty replacement flat-plate fuel element assemblies were fabricated for PRR-1 second core loading. Ten assemblies contain 155 grams ^{235}U per element, the other ten, only 137 grams. A 21st element with 137 grams ^{235}U came in as loose fuel plates only. Ninety-three per cent enriched uranium metal was alloyed with aluminum to about 11.9 weight percent of uranium utilizing 23 separate melt batches. Information on uranium contents, enrichment, uranium to Al ratio, and melt number for each fuel plate is presented. (auth)

38606 (STI/DOC-10/113) TOPICS IN LIGHT WATER REACTOR PHYSICS: FINAL REPORT OF THE NORA PROJECT. The Summary Report of the NORA International Reactor Physics Project for the Second Project Period 1964–1968. Technical Reports Series No. 113. Andersen, E.; Babala, D.; Berg, J. O.; Bryhn-Ingebrigtsen, K.; Doederlein, J. M.; Haugset, K.; Tuyn, J. W. N.; Wennemo-Hanssen, S. E. (International Atomic Energy Agency, Vienna (Austria)). 1970. 121p. (IAEA-R-104-F). IAEA $3.00.

Operations and experiments performed in the NORA critical assembly during 1964 to 1968 are reviewed. Topics discussed include: zero power reactor noise; pulsed neutron source technique; control absorber reactivities; thermal lattice spectra near absorbers; solid state nuclear track detector techniques; and cell parameters, bucklings, and reactivity coefficients. 74 references. (D.C.C.)

38607 (WAPD-TM-931) A STUDY OF PHYSICS PARAMETERS IN SEVERAL WATER-MODERATED LATTICES OF SLIGHTLY ENRICHED AND NATURAL URANIUM. Hardy, J. Jr.; Klein, D.; Volpe, J. J. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Mar 1970. Contract AT(11-1)-Gen-14. 52p. Dep. CFSTI.

The full-range Monte Carlo program RECAP was used in a consistent analysis of parameters measured in seven water-moderated uranium lattices: four were TRX lattices of slightly-enriched rods, and three were natural-uranium-slab lattices. The most important parameters were: epithermal-to-thermal ratios for ^{238}U capture (ρ^{28}) and for ^{235}U fission (δ^{25}), ratio of ^{238}U fission to ^{235}U fission (δ^{28}), eigenvalue, integral fast/epithermal spectrum comparisons with a variety of detectors, and resonance integrals for isolated uranium and UO_2 rods (calculated with the Monte Carlo program RESQ, supplemented by ZUT and TUZ at higher energies). The analysis of these lattices was fairly unambiguous and has served to test the input nuclear data for ^{238}U, ^{235}U, and H_2O. With but one exception, leakage was small (i.e., less than 20 percent), and parameters were measured in nearly asymptotic flux spectra. These measurements covered a wide range of hardness as reflected in the change of parameters: ρ^{28} ranged from 0.5 to 12; δ^{25} from 0.04 to 1.1; and δ^{28} from 0.05 to 0.44. The Monte Carlo cell calculations were corrected for leakage by means of the homogenized lattice programs P3MG and MUFT-MAGMA. With a straightforward choice of current "best" nuclear data, the calculations reproduce virtually all the parameters over the whole range of lattices.

There are two qualifications: some reduction of smooth ^{238}U capture integral is required to match the lattice measurements (by an amount barely compatible with the isolated rod measurements), and there is too much calculated epithermal ^{235}U fission in the very tight lattices. 36 references. (auth)

38608 FFTF-FAST FLUX TEST FACILITY FOR DEVELOPING BREEDER REACTOR TECHNOLOGY. Astley, E. R.; Kelly, J. C. R. Jr. (Westinghouse Electric International Co., New York). Atompraxis; 16: 198-203(May-Jul 1970).

The Fast Flux Test Facility will be the major fuels and materials test irradiation facility in the U. S. Atomic Energy Commission's Liquid Metal Fast Breeder Reactor Program. A conceptual design is presented and preliminary engineering design is discussed. (auth)

38609 THE FAST HIGH-FLUX TEST REACTOR FR 3. GOALS AND CONCEPTION. Fischer, M. (Kernforschungszentrum, Karlsruhe, Ger.). Atomwirt., Atomtech.; 15: 297-300(Jun 1970). (In German).

The first high-flux test reactor FR 3 is planned strictly as a research instrument for fast breeder reactors. It will contain several high flux test loops for the study of fuel elements, structural materials, shielding material, and safety instrumentation. Conditions in the loops will correspond to those in future breeders with various types of cooling systems. If possible, a loop for production of transplutonium elements will be included. The maximal neutron flux will be 1.5×10^{16} n/cm^2/second. Arrangement of core and test loops is depicted in six diagrams. Projected phases of development are as follows: completion of feasibility studies and cost analysis by middle of 1970; design derived under close industrial and international cooperation will be finalized by end of 1970; construction will be completed between 1974 and 1975 (H.B.G.)

38610 Sb-Be PHOTONEUTRON START-UP SOURCES FOR RESEARCH REACTORS. Bensch, F.; Boeck, H.; Prochazka, W. (Oesterreichische Hochschule, Vienna). Atomkernenergie; 15: 255-7(1970). (In German).

The applicability of Sb-Be photoneutron startup sources for research reactors is discussed. In particular, the optimum diameter ratio of an Sb rod and a Be tube for cylindrical sources has been calculated to guarantee high neutron emission. Such a startup source has been used successfully during the last two years of operation of a TRIGA reactor. 6 references. (auth)

38611 NEUTRON FLUX DISTRIBUTION MEASUREMENTS IN AND BEFORE THE THERMAL COLUMN OF THE RESEARCH REACTOR FRG-1 IN OPERATION WITH AND WITHOUT A NEUTRON BEAM TUBE. Kolb, M.; Krull, W. (Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt mbH., Geesthacht, Ger.). Atomkernenergie; 16: 35-8(1970). (In German).

The swimming pool reactor FRG-1 may be operated in a position in front of the thermal column with a maximal power of 0.2 MW or in a 2.8 m distant position before the beam tubes with a maximal power of 5 MW. To use the thermal column, too, in the case of the operation of FRG-1 before the beam tubes, a special air filled neutron beam tube was constructed with 0.5 m diameter and 2.6 m length and installed between the two positions of the reactor. Thermal and epithermal neutron flux distributions were measured with gold foils and a BF_3-proportional counter in and before the thermal column. The use of the special neutron beam tube reduced the thermal neutron flux in the thermal column by a factor of 2×10^3 for equal reactor power. The measured distributions of the thermal neutron flux can be explained with diffusion theory and lead to a diffusion length in graphite of 46.5 cm. 13 references. (auth)

38612 DEVICE FOR THE INSERTION OF IRRADIATED SAMPLES IN EXPERIMENTAL NUCLEAR REACTORS. Robin, M.; Dupuy, G.; Javellaud, J. Czechoslovakian Patent 131,196. 5 Dec 1968. Priority date 23 May 1966, France.

A device for the insertion of irradiated samples in experimental nuclear reactors with a liquid moderator is described. The device consists of a tube-shaped container placed in a box filled with the moderator. The container and the box are mounted so that they can be rotated about two parallel axes. Means for remote control of the container motion are provided. (NSA of Czech.)

38613 DETERMINATION OF REACTIVITY AND PSEUDO-REACTIVITY PERTURBATIONS IN VARIOUS CONFIGURATIONS OF THE ROSSENDORF ANNULAR CORE REACTOR RRR. PART 2. REACTIVITY AND PSEUDO-REACTIVITY PERTURBATION USING ONE-DIMENSIONAL MULTIGROUP DIFFUSION METHOD. Faehrmann, K. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Kernenergie; 13: 81-5(Mar 1970). (In German).

After a brief introduction into reactivity perturbation measurement and calculation, the calculation of reactivity perturbations caused by a thermal absorber and the pseudo-reactivity perturbations due to a fast neutron source is described. The calculation model corresponds to an empirically improved first-order perturbation theory. Evaluation of the reactivity normalizing integrals according to the PERT program is based on the real and adjoint group fluxes calculated in the one-dimensional multigroup diffusion approximation using the 26 group ANB set by means of MCO and MCO-ADJ programs. Comparison with experimental data gives good agreement of the fast to thermal neutron influence ratios and of the reactivity variation when simple transport approximation for hydrogen is used. 9 references. (auth)

38614 OPTIMIZATION OF FUEL LOADINGS FOR HIGH POWER TEST REACTORS. Reilly, H. J.; Peters, L. E. Jr. (Lewis Research Center, Cleveland). Nucl. Appl. Technol.; 9: 356-63(Sep 1970).

A method was developed for determining the optimum fuel utilization for the Plum Brook Reactor (PBR). The method used available PBR criticality data to incorporate the effects of neutron leakage and nonuniformity of burnup in a point model of the core. This allowed the model to predict the performance of the core as a function of new element weight and number of uses per element. A graphical model was devised to determine the optimum. The derivation of the model and its application for a typical PBR configuration is described. (auth)

38615 ANALOG STUDY OF THE AUTOMATIC CONTROL SYSTEM FOR THE RA-3 REACTOR. Murmis, B.; Huber, H. pp 235-42 of Analog and Hybrid Computation Applied to Nuclear Energy. Brussels, Presses Academiques Europeennes (1969). (In French).

From International Symposium on Analogue and Hybrid Computation Applied to Nuclear Energy, Versailles, France. See CONF-680941.

The RA-3 is a 5 MW(t) research reactor using enriched U fuel and moderated and cooled by light water. The automatic control system will permit stabilization of the power and automatic changes between levels of the same decade. The system and the results of an analog analysis of its operation are described. (7 references) (H.D.R.)

Rocket and Space Reactors

38616 DYNAMICS OF A POWER SUPPLY WITH A MODERATED THERMIONIC REACTOR. Wolf, E.; Speidel, V. (Univ., Stuttgart). Atomkernenergie; 16: 19-28(1970). (In German).

The dynamic behavior of a power supply for spacecraft comprising a moderated incore thermionic reactor (ITR) and a heat-pipe radiator is studied from a self-stabilising point of view. Stability boundaries of the temperature coefficients of reactivity are determined by means of Nyquist-theorem. The degree of stability of the nonlinear system is examined with the aid of maximum overshoot and rise time of the emitter temperature after a reactivity step. Under certain conditions the heat transfer characteristics of the thermionic converters show a statistically unstable region located near the maximum power working point of the converters. If in the course of a regulation process the converter parameters reach that region, there will be a large fuel temperature rise which may result in a destruction of the thermionic fuel elements. The time lapse of this kind of fuel burnout is discussed by investigating the step response of the nonlinear system for some examples. 9 references. (auth)

38617 USE OF HYBRID SIMULATION TECHNIQUES IN THE NUCLEAR ROCKET PROPULSION PROGRAM. Murray, Hugh S.; Milich, Charles P.; Springer, Thomas E.; Balcomb, J. Douglas (Los Alamos Scientific Lab., N. Mex.). pp 135-8 of Analog and Hybrid Computation Applied to Nuclear Energy. Brussels, Presses Academiques Europeennes (1969).

From International Symposium on Analogue and Hybrid Computation Applied to Nuclear Energy, Versailles, France. See CONF-680941.

The hybrid computer equipment and techniques used at the Los Alamos Scientific Laboratory to predict the dynamic behavior of nuclear rocket propulsion systems are described. (H.D.R.)

Process Heat and Desalination Reactors

38618 (JUL-656-PA) HIGH-TEMPERATURE REACTOR FOR DESALTING SEA WATER. Schwegmann, P.; Bonnenberg, H.

(Kernforschungsanlage, Juelich (West Germany)). Mar 1970. 48p. (In German). Dep. CFSTI (U. S. Sales Only).

Discussion is presented on the use of HTGR for the conversion of seawater to fresh water. The economics of a dual-purpose electricity-desalination plant making use of a high temperature reactor as the heat source, gas turbine, and multistage-flash distillation are analyzed and compared with single-purpose plants. Capital costs, fuel costs, and costs for operation and maintenance have been computed on the basis of recently published information. As a result of the investigations it is concluded that the gas process is suitable for nuclear dual-purpose plants up to a water-to-power ratio of approximately 15 kg/kWh depending on capacity compared to a ratio up to 160 kg/kWh for steam processes. 28 references. (auth)

38619 STEAM GENERATOR MODEL FOR DUAL PURPOSE NUCLEAR POWER PLANT SIMULATION. Saphier, D.; Wolberg, J. R.; Yiftah, S. (Technion-Israel Inst. of Tech., Haifa). pp 183-90 of Analog and Hybrid Computation Applied to Nuclear Energy. Brussels, Presses Academiques Europeennes (1969).

From International Symposium on Analogue and Hybrid Computation Applied to Nuclear Energy, Versailles, France. See CONF-680941.

A project to analyse the dynamic behavior of a dual purpose (electricity production and sea water desalination) nuclear plant was undertaken. The study was performed by simulating the total plant on an analogue computer. A report on the development of a space-averaged mathematical model of the steam generator and its simulation, as a part of the above plant, is presented. (auth)

Marine and Portable Power Reactors

38620 (CONF-700211-1) BUILDING OF NUCLEAR SHIP "MUTSU." (Japan Nuclear Ship Development Agency, Tokyo). Mar 1970. 6p. Dep. CFSTI (U. S. Sales Only).

From Atomic Energy Society Meeting, Tokyo, Japan.

Design parameters of the ship and the reactor propulsion unit are presented. A flow diagram of the reactor system is included. The construction schedule is outlined. (D.C.C.)

Reactor Theory

38621 ANALOG/HYBRID SOLUTION OF PARTIAL DIFFERENTIAL EQUATIONS IN THE NUCLEAR INDUSTRY. Vichnevetsky, R. (Electronic Associates, Inc., Princeton, N. J.). pp 22-35 of Analog and Hybrid Computation Applied to Nuclear Energy. Brussels, Presses Academiques Europeennes (1969).

From International Symposium on Analogue and Hybrid Computation Applied to Nuclear Energy, Versailles, France. See CONF-680941.

Mathematical models of nuclear reactors and nuclear power plants often contain partial differential equations in space and time. The mathematical methods used for the simulation of these transient field problems are reviewed, and the advantages of analog/digital hybrid computers for nuclear plant simulation are discussed. (51 references) (H.D.R.)

Kinetics

Refer also to abstract 38488.

38622 (RD/B/N-1645) CORRECTIONS TO THE BENOIST DIFFUSION COEFFICIENTS FOR CAGR-TYPE LATTICES. Bridge, M. J.; Howarth, N. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Mar 1970. 30p. (JNPC/RPWP/N-426). Dep. CFSTI (U. S. Sales Only).

An error was discovered in the Benoist theory of cell diffusion coefficients. It is shown that, in addition, there are some further terms (related to the tilted flux component and neglected in the Benoist formulae) which become important for CAGR type lattices. These theoretical corrections were confirmed in slab geometry by comparison with diffusion coefficients derived on neutron balance grounds from heterogeneous CRAM diffusion theory calculations. A possible scheme for calculating the corrections to Benoist type diffusion coefficients in cylindrical geometry is outlined. A method of obtaining dipole boundary conditions for heterogeneous codes consistent with these diffusion coefficients is given. The use of these dipoles improves the calculation of cross-channel gradients as is shown by a comparison of some results with experiment. (auth) (UK)

38623 SOLUTION OF THE BOLTZMANN-NEUTRON TRANSPORT-EQUATION IN PLANE GEOMETRY WITH ANISOTROPIC SCATTERING BY THE DOUBLE-P_N-METHOD. Schumann, U. (Technische Univ., Berlin). Atomwirt., Atomtech.; 15: 341 (Jul 1970).

38624 TABLES FOR THE EVALUATION OF ROD-DROP MEASUREMENTS. Breitenhuber, L.; Huber, H. (Institut fuer Kernphysik, Graz). Atomkernenergie; 15: 259-62(1970).

On the basis of thermal fission data the reactivity vs. flux density ratios (amplitude method) is given for a number of suitable fixed times after the rod-drop as parameter. The tables have been calculated by a direct integration with a Runge-Kutta code of fourth order and provide each cent to avoid interpolation. For large reactivities an iteration of the integral form of kinetic equations has been numerically evaluated and used to check the results of the immediate integration. The necessary coefficients are tabulated for the fourth approximation. A perturbation formula is derived to estimate the effect of finite dropping times. (5 references.) (auth)

38625 AT-POWER REACTOR NOISE INDUCED BY FLUCTUATIONS OF THE COOLANT FLOW. Seifritz, W. (Technische Univ., Hanover). Atomkernenergie; 16: 29-34(1970).

With the ultimate goal of detecting anomalous behavior of reactor components by noise analysis, the theory of neutron fluctuations is developed for an at-power reactor perturbed by stochastic irregularities in the rate of coolant flow. The mathematical treatment is carried out on the basis that a two-region (fuel and coolant) reactor operating with two corresponding reactivity coefficients is cooled by a liquid according to Newton's law. Two types of coolant with respect to the Prandtl numbers (e.g., water and liquid metals) are considered. 9 references. (auth)

38626 SOLUTION OF THE MULTIGROUP-NEUTRON-DIFFUSION-EQUATIONS WITH THE ADJOINT METHOD. Royl, P. (Inst. fuer Kernenergetik, Stuttgart); Bartsch, G. Atomkernenergie; 16: 39-42(1970). (In German).

The adjoint method from Mises-Koch is employed for the solution of the matrix-eigenvalue problem that is generated by the multigroup-diffusion-equations for the spherical reactor with reflector after introducing difference-equations. This method starts with two arbitrary vectors for the flux and the adjoint flux which are improved by vector-iteration. The eigenvalue (core-radius or atomic density) is calculated after each iteration from the Rayleigh-Quotient, which converges very fast toward the dominant eigenvalue. The eigenvector and the adjoint eigenvector of the lowest positive eigenvalue give the flux and adjoint flux distributions for all space-points and energy-groups. Higher eigenvalues can be calculated by this method. Compared with the source iteration this method gives the adjoint flux and the flux in one calculation together with the eigenvalue, the source iteration would need an additional iteration for the adjoint flux. The example of the spherical reactor that is given is restricted on calculations with few groups and space points because of the computer storage. A way is shown by which band matrices can be introduced so that very high group approximations with arbitrary numbers of space-points and zones become possible. (auth)

38627 AUTOMATIC RESCALING OF THE NEUTRON KINETIC EQUATIONS WITH A HYBRID COMPUTER. Denmead, J. K.; Kingdon, F. C. pp 77-83 of Analog and Hybrid Computation Applied to Nuclear Energy. Brussels, Presses Academiques Europeennes (1969).

From International Symposium on Analogue and Hybrid Computation Applied to Nuclear Energy, Versailles, France. See CONF-680941.

Two techniques are described whereby the facilities offered by the present generation of analogue/hybrid computers are used to implement automatic rescaling and also to add in other ways to the convenience and usefulness of the computing process. The first method utilizes a combination of analogue components and patchable logic elements. For the second method a full hybrid system is used with most of the patchable logic and some of the analogue components replaced by software instructions on a digital computer. Illustrations are given of the results obtained and comparisons are made between them and also with a purely digital solution which was used to verify the accuracy of certain cases. (auth)

38628 ADVANCES IN THE HYBRID SIMULATION OF NUCLEAR REACTOR TRANSIENTS. Sanathanan, C. K. (Univ. of Illinois, Chicago); Sandberg, A. A.; Carter, J. C.; Bryant, L. T.

pp 111-20 of Analog and Hybrid Computation Applied to Nuclear Energy. Brussels, Presses Academiques Europeennes (1969).

From International Symposium on Analogue and Hybrid Computation Applied to Nuclear Energy, Versailles, France. See CONF-680941.

The feasibility of using a hybrid computer for the analysis of the transient behavior of a reactor core is discussed. New techniques which have increased the effectiveness of hybrid computers as a means of analysing reactor systems are reviewed. (10 references) (H.D.R.)

38629 HYBRID SIMULATION OF NUCLEAR REACTOR SYSTEM STOCHASTIC MODELS. Kemeny, Leslie G. (Univ. of New South Wales, Kensington, Australia). pp 121-34 of Analog and Hybrid Computation Applied to Nuclear Energy. Brussels, Presses Academiques Europeennes (1969).

From International Symposium on Analogue and Hybrid Computation Applied to Nuclear Energy, Versailles, France. See CONF-680941.

Methods of generating suitable noise-like signals for the hybrid simulation of nuclear reactor system stochastic models are discussed. Techniques are proposed for the correlation of theory and experiment in terms of the hybrid computer programme. Possible schemes for reactor system identification and control based on the impulse response criterion are given. The use of Fokker–Planck type equations in the synthesis of control systems for non-linear, non-stationary systems subjected to stochastic perturbations is outlined. Examples of measured and simulated reactor system noise spectra and correlograms are presented. (auth)

Dynamics

38630 RESOLUTION OF THE DIFFUSION EQUATION BY MEANS OF ANALOG CALCULATORS WITH DIRECT CURRENT (PROBLEMS OF MESHING AND OF LIMIT CONDITIONS). Chaigne, M.; Chareton, H.; Di Falco, Ch.; Poulard, P. pp 84-95 of Analog and Hybrid Computation Applied to Nuclear Energy. Brussels, Presses Academiques Europeennes (1969). (In French).

From International Symposium on Analogue and Hybrid Computation Applied to Nuclear Energy, Versailles, France. See CONF-680941.

Two examples of the application of direct current analog computers to solution of diffusion equations are presented. The diffusion of a saline tracer in water cooled reactor systems and the heat transfer and thermal constraints in a sodium cooled reactor system are analyzed. (H.D.R.)

38631 RESISTANCE ANALOG COMPUTER FOR REACTOR HEAT CONDUCTION PROBLEMS. Strupczewski, Andrzej (Inst. of Nuclear Research, Swierk, Poland). pp 144-52 of Analog and Hybrid Computation Applied to Nuclear Energy. Brussels, Presses Academiques Europeennes (1969).

From International Symposium on Analogue and Hybrid Computation Applied to Nuclear Energy, Versailles, France. See CONF-680941.

A new way of simulating solids with internal heat sources is presented, this case being of prime importance for reactor problems in heat transfer. The proposed method of simulation has been used in the construction of a flexible resistance analog computer used for solving problems of any geometry, with arbitrary boundary conditions and internal heat source distribution. The analysis of accuracy proves that this computer can be successfully used for solving reactor heat conduction problems with the errors of solution remaining within limits of 1 to 2%, depending upon the complexity of the problem. Finally, the actual solution of a transient heat conduction problem in a reactor core is described and a comparison with other methods of solution presented. (11 references) (H.D.R.)

Experimental Applications

Refer also to abstracts 38583, 38607, and 38613.

38632 (ANL-7411(Suppl.4)) ARGONNE CODE CENTER: COMPILATION OF PROGRAM ABSTRACTS. Butler, M. K.; Legan, Marianne; Ranzini, L.; Snow, William J. (Argonne National Lab., Ill.). May 1970. Contract W-31-109-eng-38. 213p. Dep. CFSTI.

A bibliography of computer abstracts referring to available computer programs at the Argonne Code Center is presented. (D.C.C.)

38633 (KFK-1140) RESULTS OF ERROR ANALYSIS FOR IN-PILE THERMAL CONDUCTIVITY DETERMINATIONS BY THE BALANCED OSCILLATOR METHOD. Daenner, W. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Reaktorentwicklung). Jan 1970. 37p. (In German). Dep. CFSTI (U. S. Sales Only).

With respect to the in-pile application of the Balanced Oscillator Method for measuring the fuel thermal conductivity and the gap conductance, a detailed error analysis has been performed. Observing the postulated optimal test conditions the thermal conductivity could be obtained with a precision of about 15 to 20%, the gap conductance with about 20 to 40% during the entire burnup of the specimen. Necessary improvements of the test loop instrumentation and essential experiments are advised. Some experimental problems of running the measurements in the FR2 are discussed. 8 references. (auth)

38634 SOME POSSIBILITIES OF APPLICATION OF PULSED NEUTRON SOURCE IN THE STUDY OF NONMULTIPLYING SYSTEMS WITH LOCAL INHOMOGENEITIES. Yurova, L. N.; Romodanov, V. L.; Smirnov, V. E.; Pankratenko, D. A. This paper was summarized in At. Energ. (USSR); 26: 539(Jun 1969) as paper No. 305. (In Russian).

The variation in the magnitude of the α-constant of decay of thermal neutrons in the method of pulsed source is achieved by varying the geometrical dimensions of the measured system and also its physical properties by introducing into it any substance in homogeneous or discrete form. The possibility of varying the magnitude of α in a nonmultiplying medium of finite dimensions by spatial displacement of local inhomogeneity at a constant ratio of the volume of the inhomogeneity and the volume of the medium is discussed. Two experiments were conducted. The first experiment was carried out in a parallel-plane system with dimensions $8 \times 43 \times 57$ cm and filled with water. The investigated inhomogeneities were represented by samples of aluminum of thickness 5 and 15 mm, and duralumin of thickness 8 mm, an air gap of thickness 5 mm and two H_3BO_3 solutions in this gap with different concentrations of boron. The second experiment was conducted in a cylinder, 17 cm in diameter and 12 cm in height, also filled with water. The inhomogeneities were investigated in the form of copper cylinders with diameters of 1, 1.4, and 2 cm and graphite cylinders with diameters of 3, 4, and 5 cm. The results of the second experiment are presented. The theoretical possibility of measuring the diffusion constant of a substance occurring in small quantity is pointed out. (auth)

38635 NEUTRON REFLECTION AND INTERSPERSED MODERATION OF UNDERMODERATED PLUTONIUM SLABS WITH COMPOSITE REFLECTORS. Thomas, Wolfgang (NUKEM, Hanau, Ger.). Atomkernenergie; 16: 43-7(1970). (In German).

Calculations have been made of the influence of metal and metal-water reflectors on reactivity of a strongly undermoderated plutonium core in slab geometry. Especially lead and stainless steel have been taken as reflectors up to 30 cm thick. Further the strong effect of metal claddings on cadmium poisoning is investigated. Energy-dependent reflection coefficients can be given for some composite reflectors. The influence of composite interspersed media on neutron interaction between undermoderated plutonium slabs is examined. It is shown that no increase in reactivity is possible for an interspersed water moderator behind 8 mm steel or layers of lead thicker than 5 cm. The presence of cadmium behind 5 cm thick steel causes no change in reactivity whereas lead has only little effect on a neutron poison. 12 references. (auth)

Reactor Components, Fuels, and Accessories

Refer also to abstracts 36171, 36463, 36530, 36560, 36586, 36673, 36857, 36858, 36864, 36875, 36884, 36892, 36900, 36912, 36922, 36940, 36950–36953, 36959, 36966, 36970, 36996, 36997, 36999, 37000, and 38470.

38636 (DOCKET-1155-55) LA CROSSE BOILING WATER REACTOR. Monthly Operating Report No. 17, November 1968. (Allis-Chalmers Mfg. Co., Bethesda, Md. Atomic Energy Div.). Contract AT(11-1)-850. 23p. (ACNP-68516). Dep. CFSTI.

38637 HEAT TRANSFER AND PRESSURE DROP OF TUBES WITH HERRINGBONE, TRANSVERSE, AND LONGITUDINAL FINS FOR GAS COOLED FUEL ELEMENTS. Presser, K. H.; Harth, R. (Kernforschungsanlage, Juelich, Ger.). Atomkernenergie; 15: 217-26(1970). (In German).

Mean and local heat transfer coefficients and friction factors of

tubes with herringbone, transverse and longitudinal fins of magnesium alloy were measured in the range $2 \cdot 10^3 < Re < 10^7$ at $0.72 < Pr < 0.85$. Finned tubes are heated by electric direct current or by saturated steam. Carbon dioxide and air were used for cooling. For the qualitative classification of fin tubes a relative performance coefficient is defined. At identical specific cross sections the heat transfer for herringbone finned tubes is 4 to 20 times, for transverse and longitudinal finned tubes 1.6 to 2.6 times greater than for smooth tubes. Relative performance coefficients >1 (max. 3) were obtained for herringbone finned tubes over an extended range of specific cross sections. It is supposed, that this is the result of the repeated entrance effects. If the herringbone finned tube is the central rod of an annulus, the diameter variation of the smooth channel tube influences the pressure loss but not the heat transfer. Both energetic qualities and compactness of the volume of herringbone finned tubes are superior to transverse and longitudinal finned tubes. Disadvantages of herringbone fins are the high costs and the limitation of light metals. (23 references.) (auth)

38638 ELEMENT IN SHELL NUCLEAR FUEL ASSEMBLY. Ip, A. Kwok-chun. Canadian Patent 843,050. 26 May 1970.

An improved fuel assembly is described for use in a reactor consisting of an elongated shell containing nuclear fuel with several lengthwise coolant passages. Elongated insert fuel elements of lesser transverse dimension than the coolant passages supported within the passages are also included to provide increased heat transfer surface and to promote higher efficiency of energy generation. The mass of fissile material per unit length of the assembly is significantly greater than that of a tube-in-shell assembly containing no insert elements whereby the heat flux is significantly increased for a given temperature. (F.S.A.)

38639 A HANDLING ARM FOR FUELLING A NUCLEAR REACTOR. Benoist, Etienne; Marmonier, Pierre; Michot, Gilbert (to Commissariat a l'Energie Atomique). British Patent 1,198,042. 8 Jul 1970. Priority date 6 Mar 1968, France.

REACTOR LOADING MACHINES—design parameters of hollow tube rotating arm grab operation (D.C.C.)

38640 EXPERIENCES WITH THE MANUFACTURE OF NUCLEAR TECHNOLOGY PARTS. Benedict, G. Atomwirt., Atomtech.; 15: 273-4(Jun 1970). (In German).

In the manufacturing of nuclear technology parts by conventional machine factories, a series of problems are encountered that lead to excessive rejects, delays, and cost overruns. One major difficulty consists of welding of parts resulting in too much shrinkage. Discussed are type of material and welding procedure, product testing, and various solutions to problems. In addition, practical experience with the manufacturing of fuel elements and control rods are reported. (H.B.G.)

38641 AGGLOMERATIONS OF COATED NUCLEAR FUEL PARTICLES. Redding, Geoffrey Brian (to United Kingdom Atomic Energy Authority). British Patent 1,195,206. 17 Jun 1970. Filed 25 Oct 1966.

Reference is made to methods for making agglomerations of coated fuel particles by the use of synthetic resins applied as overcoatings on the particles. A layer of synthetic resin is applied by tumbling the coated particles. The mass of particles is then compacted and heat is applied to the mass in such a way that the mass is zone heated to a temperature at which a marked reduction in viscosity and curing of the resin occur and compaction and agglomeration occur progressively throughout the mass. Alternatively, the resin coated particles may be vibrocompacted in an elongated vessel and a thermal front caused to move throughout the mass of particles to cure the resin. An example described involves the use of a carbonisable thermosetting resin in powder form mixed with graphite powder applied to the coated particles, compacting at a pressure of 2,000 psi and applying zone heating. A further example involves introducing the resin coated particles into an elongated bore in a graphite body, applying vibrocompaction, and causing a thermal front to move through the agglomeration of particles. By these methods a solid cylinder of agglomerated fuel particles can be formed having a substantially uniform and high density, with a length/diameter ratio of 24/1 or more. (UK)

38642 NATURAL OR ENRICHED URANIUM. Leo, Bertrand (Electricite de France, Paris). Rev. Fr. Elec.; 43: 28-33(1970). (In French).

The factors influencing the choice of power reactor fuel to be undertaken by France are discussed. The technical, political, and economic aspects are considered. (auth) (France)

38643 NUCLEAR FUEL ELEMENTS. Yates, Jack; Rostron, Norman (to United Kingdom Atomic Energy Authority). British Patent 1,195,222. 17 Jun 1970. Filed 15 Jul 1966.

Reference is made to plate type nuclear fuel assemblies and to means for location of the fuel plates within the assembly. The assembly includes a member having slots for locating the edges of the fuel element plates. This member is tilted relative to the plates so that they are caused to bind in the slots. The edges of the fuel element plates may be located in slots in comb-like members disposed at intervals along the length of the edges. The slots may be skewed about the edges so that comb-like members jam on the edges. A pinch may be applied to the edges. The members may be secured by welding to an all-embracing shroud, and the slots may be tapered. (UK)

38644 FUEL ELEMENT FOR NUCLEAR REACTORS. Kumpf, H. Canadian Patent 841,849. 12 May 1970. Priority date 19 May 1965, Germany.

A fuel element for water-cooled reactors is described having a supercritical pressure zone with fuel rods located and spaced parallel to one another. There are several tubular inserts located intermediate to the fuel rods and formed, on a side facing toward the rods, with flow-guiding and vortex-producing means for a fluid coolant traversing the fuel element. The flow-guiding means serve simultaneously for spacing the fuel rods relative to each other and the inserts are of such construction that coolant on the side of the inserts facing away from the fuel rods is of average lower temperature than the coolant on the side of the inserts facing toward the fuel rods. Also provided are means for distributing the coolant which are located at only one end of the fuel element and are formed with means for supplying the coolant to the fuel element and for discharging it. (F.S.A.)

38645 IMPROVEMENTS RELATING TO CONTROL SYSTEMS FOR NUCLEAR REACTORS. Dean, John Raymond (to A. Reyrolle and Co. Ltd.). British Patent 1,195,834. 24 Jun 1970. Filed 29 Jun 1966.

Disadvantages of current methods of introducing control rods rapidly into a reactor core in emergencies are outlined, and an improved actuator arrangement applicable to reactors in which the control rods are inserted vertically upwards into the core from below is described. The arrangement is stated to provide the required acceleration without the drawbacks of current systems, and with greater reliability. The control rod driving system comprises a driving mass coupled to the control rod assembly by a transmission mechanism arranged so that the downward movement of the mass, when descending under gravity, produces a corresponding upward movement of the control rod assembly, the velocity and acceleration depending on the velocity ratio of the transmission mechanism. A motor/brake unit is also coupled to the control rod assembly and is operable to oppose the action of the driving mass and raise or lower the control rod assembly at a controlled speed or to brake the control rod assembly and hold it in a desired position during normal working of the reactor. Means are also provided for disconnecting the motor/brake unit from the control rod assembly in an emergency and thus allow its rapid upward insertion. The motor/brake unit may be mounted below the control rod assembly so as to drive a winch drum on which is wound an upwardly extending cable connected to the lower end of the control rod assembly, and the transmission mechanism may comprise a chain and sprocket or cable and pulley mechanism. The control rod assembly may be coupled to the motor/brake unit through a releasable magnetic clutch which constitutes the emergency disconnecting means. A fixed stop may be provided for limiting the downward movement of the driving mass, and the driving mass may be formed in two or more parts arranged to telescope as they successively engage the stop. (UK)

38646 EFFECTS OF DIFFERENT TYPES OF VOID VOLUMES ON THE RADIAL TEMPERATURE DISTRIBUTION OF FUEL PINS. Kaempf, H.; Karsten, G. (Institut fuer Angewandte Reaktorphysik, Karlsruhe, Ger.). Nucl. Appl. Technol.; 9: 288-300(Sep 1970).

The thermal effects of different types of void volumes within a fuel pin, such as porosity, central void, and the gas gap between fuel and clad are examined. A new general relation for the dependence of thermal conductivity on the closed porosity is deduced. For given gas contents and specific ranges of pore temperatures and sizes, a simple approximate equation is set up, which is in good agreement with experimentally obtained results. A central void is very effective in reducing the maximum temperature; and its use implies a considerable increase in linear pin power. In-pile migration of the porosity in the hotter regions of oxide fuel pins forms or increases the central void and densifies the hotter region. This effect is calculated in a two-zone porosity model. For a uniform gap between fuel and clad the temperature drop is calculated as a function of gap width, linear pin power, inner temperature of clad, inside radius of clad, emissivities of surfaces, and types of gas within the gap, such as noble gases and mixtures of He with gaseous fission products. 26 references. (auth)

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